THE ENGINEERING MAGAZINE

THE WORLD IS ITS FIELD

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MODERN ADAPTATIONS OF THE APPRENTICESHIP SYSTEM.

By O. M. Becker.

Mr. Becker's introductory article in our preceding issue reviewed the general conditions of modern industry which make the question of supplying "the mechanic of the future" a vital one. His concluding paper, in the pages following, shows what is actually being done by leading companies and representative employers.—THE EDITORS.

IT ought to need no argument to show that the best apprentices, the only kind it is desirable to spend time and effort to educate for mechanics, can be obtained only through careful selection from among boys of superior character and of sufficient schooling to have gotten a suitable mental horizon. There is a certain amount of "book learning" that is not only useful to the skillful mechanic, but which is essential to his highest efficiency. Mathematics, for instance. I have known apprentices who were absolutely ignorant of the divisions of the inch! Now it is of course possible that an excellent apprentice may be occasionally found among boys that have had little opportunity for schooling. If so, he will be able to make up the deficiency, if given the chance. It is unprofitable however to take chances with haphazard selections. The custom of the Brown & Sharpe Manufacturing Co., and other houses with successful experience in apprenticeship, is to take no boy who has not graduated from the grammar schools or who has not an education equivalent to that required for such graduation. There is no lack of such boys. The problem is not so much one of getting as of keeping satisfactory apprentices. Of this I shall have more to say later.

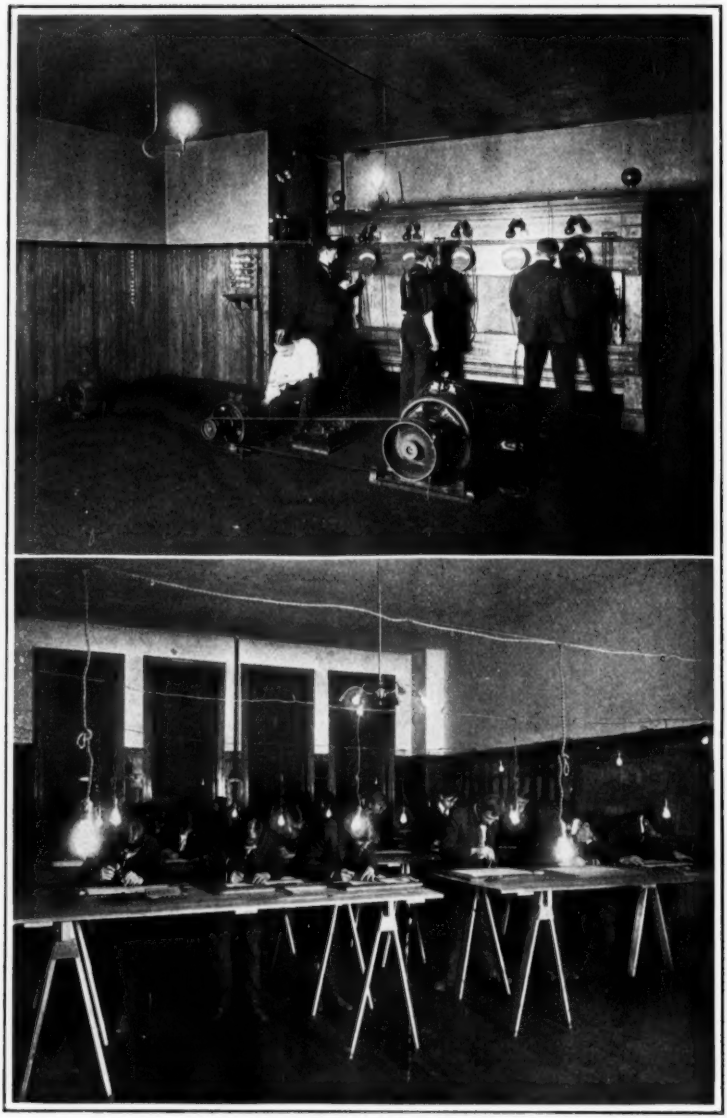
The amount and kind of instruction that may be profitably given in addition to that already mentioned may vary greatly. If the apprentices be carefully selected with reference to capabilities and pre-

vious schooling, there will be less need for academic instruction. The ordinary practice is to accept anybody that may offer, without much regard to his previous history, home training, or schooling. Few American employers of apprentices have been accustomed to give or require any academic instruction for their boys, and not a few have expressed themselves to the effect that such instruction is not only useless but actually harmful, as tending to make the boys discontented. It is not at all strange that shops managed on this principle should fail to turn out high-class journeymen. What could be more obvious than that a good mechanic needs a good working knowledge of mathematics, the elements of physics, and mechanical drawing? In particular trades, as electrical workers for instance, other subjects are essential also. The practice as to the imparting of this instruction varies. In some cases the apprentices are merely required to get the instruction as best they can, at night schools or through correspondence courses, the employer only requiring certificates showing the prescribed work to have been done satisfactorily. In most manufacturing centers there are schools holding evening sessions where such instruction may be had, either free or at nominal cost. Some employers find it profitable to arrange with certain schools, preferably those equipped for giving instruction in mechanics and technics as well as in academic subjects, for the instruction of their apprentices, usually without cost to the latter. Others go still further and have this instruction given during working hours, or in the evening with some reduction in the working hours without loss of pay. The common-sense in such a practice is quite evident when once thoughtfully considered. An hour, say, dropped from the end of the work day at such times as the apprentice attends his evening class, allows him to do so with some comfort. He is able to get his meals and change his clothes properly, and goes to school with increased interest and self-respect. There is a growing tendency to regard the time given to such instruction, particularly if given during working hours, as a legitimate portion of the working time of the apprentice, and to pay for it accordingly.

Along with this tendency is another, to provide such instruction largely or wholly in connection with the shop or factory, by the organization of classes in the required subjects, in charge of men who have both teaching skill and practical knowledge of the business. When such instructors can be found in the shops of the employer, this arrangement is likely to be the most efficient, and economical also. It has the advantage of bringing the instruction to bear

THE APPRENTICE SCHOOL OF R. HOE & CO., N. Y.

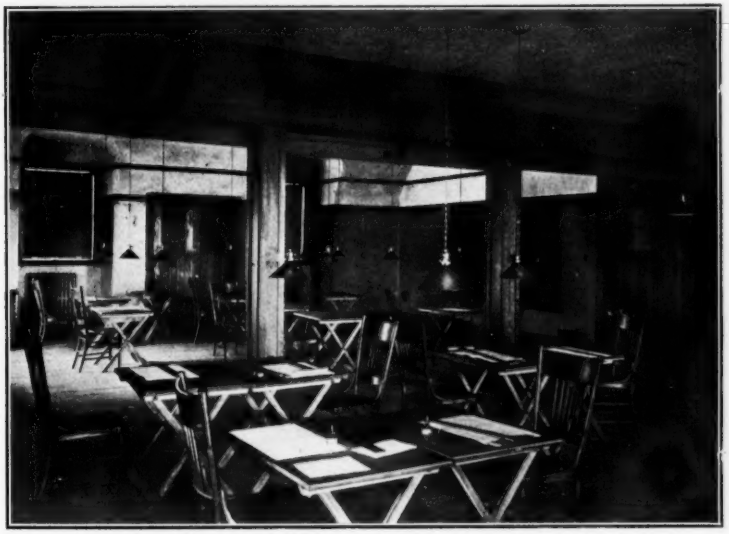
The instruction is concrete, so far as possible, as suggested by the upper picture, taken in the class in mechanics. It deals largely with problems and difficulties likely to be met in the regular work in the shops. The period of indenture is five years, and great care is used in admitting only the most desirable applicants.



IN THE CASINO NIGHT-SCHOOL, MAINTAINED BY THE WESTINGHOUSE COMPANIES.

Apprentices receive instruction in mechanical drawing and other subjects at nominal cost. The upper view shows apprentices testing generators.

directly upon the problems the apprentice meets in his shop, and of permitting a greater variety of exercises in the mechanical or technical subjects, both on the theoretical and practical side. The actual practice in pattern making or founding, for instance, as given in any school is not only limited in amount but of doubtful value. If the apprentice gets the theory of the thing while working in his own shop and on the pieces he makes or helps make every day, it undoubtedly has a greater value than if it were given him in a more or less abstract way and under conditions difficult to relate to those of the commercial shop in which he works.



CLASS ROOM IN THE MC CORMICK WORKS CLUB HOUSE.

Connected with the McCormick works of the International Harvester Co., Chicago. Instruction is given at a nominal cost.

The important thing in such instruction is not so much how it is given, but that it actually *be given*, and given in sufficient quantity and of proper quality. Under such conditions there will be little, if any, necessity for apprenticeship periods as long as the customary four years, except possibly for that class of apprentices seeking to become familiar with the business as a whole rather than to become mechanics in particular trades. The rapid advance in skill and competency which the boys may be expected to make under the conditions of proper instruction, and which experience has shown they actually do make, permits the "writing off" of a considerable part

of the period of indenture, sometimes as much as a half of it. Not that a boy can be expected to become an expert mechanic in even four years, any more than a similar number of years would make an experienced business man of him. But the foundation for his future experience and the fundamental facts and operations of his trade can well be acquired in that time, and often less, as pointed out.

A CLASS OF GRADUATE APPRENTICES, NATIONAL CASH REGISTER CO., DAYTON, OHIO.

The question of what to do with those young men and boys who become apprentices after having taken high-school, manual-training, or even technical courses, presents no practical difficulties. It is merely a matter of determining from their work in the shop the degree of competency, and of making a suitable credit on the time of their apprenticeship. Of course, if any of these are accepted with the idea of becoming technical men rather than mechanics, it is desirable to put them into a separate class or group, arranging for them that special course of training which will give them the practical experience in the shop which is their chief need. In large works needing the services of many high-grade technical men such a class would be as necessary as that for the mechanics.

Returning again to the matter of keeping apprentices in the shop for the full period of the apprenticeship: It is undoubtedly true that

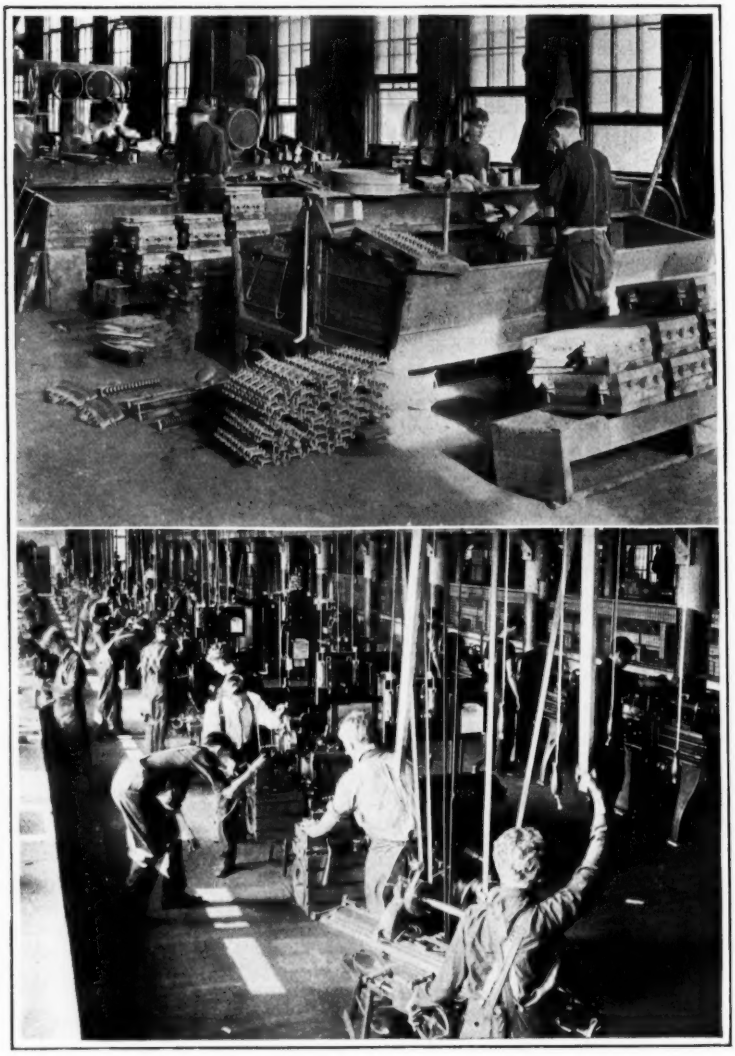
the tendency of the ambitious American boy is toward the professions, business, and administration. There is however ample evidence that plenty of bright boys, also ambitious, are ready to enter the trades if the conditions be such as do not impose what seems too great a handicap. Long periods of indenture have been pointed out as one such obstacle in the way of securing satisfactory apprentices. The standard of living and working is distinctly higher than in the past, and so it comes that many are disinclined to work under the conditions prevailing in many shops. The lack of consideration shown employees in these shops, the contemptuous disregard for the common decencies, even, in some cases, quite warrant a high-

APPRENTICES LINING UP A LOCOMOTIVE AT THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

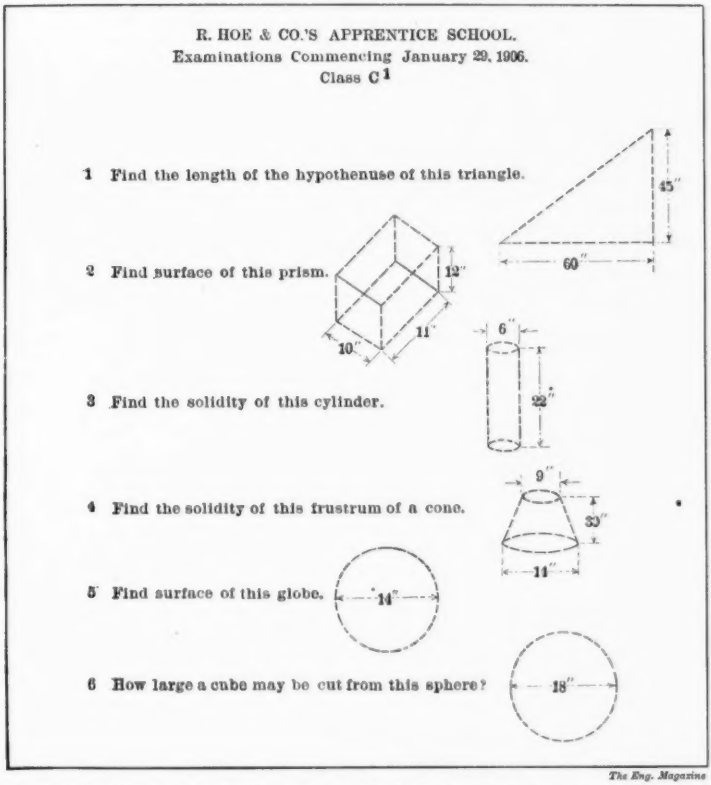
The one in charge is a third-year engineering apprentice. It is part of the policy to teach apprentices to carry responsibility.

spirited boy in his disinclination to work in them. Having agreed to the term of apprenticeship, he is of course morally bound to complete it. Nevertheless no boy can be greatly blamed for leaving such conditions when he finds himself in their midst.

Happily such environments do not exist in many other shops. There is a growing disposition to make working conditions at least



APPRENTICES IN FOUNDRY AND MACHINE SHOP. WEST LYNN WORKS OF THE GENERAL ELECTRIC CO.



The Eng. Magazine

AN EXAMINATION PAPER, APPRENTICE SCHOOL OF R. HOE & CO., NEW YORK.

comfortable and decent, if not agreeable. But even in such shops, apprentices break their contracts and leave before the end of the term, and often take employment elsewhere at the end of the term when they do complete it. The cause lies more often in the spirit of the employer or of his establishment—which is in the end the same thing—than in the boy. True, the boy has, like his employer, the dollar fever, and with much the same lack of foresight wants to get the coin immediately. He gets a smattering of shop knowledge and a little skill, and hunts up another job that pays a little better than his apprenticeship, overlooking the future disadvantage such a course involves, or perhaps disregarding it in the hope that he may circumvent it.

AGREEMENT

This Agreement, made the.....day of.....A. D. 19.....; by and between THE WARNER & SWASEY COMPANY, Cleveland, Ohio, party of the first part, ...of.....party of the second part, and.....of.....party of the third part.

Witnesseth, That the party of the second part shall from the date hereof, for a term of.....years, and so much longer as may be necessary to make up lost time, become and be the apprentice of the party of the first part to the art and trade of MACHINIST, under and according to the terms and provisions contained in "CONDITIONS OF APPRENTICESHIP" hereto annexed and made a part hereof, and that said parties of the first and second parts will well and truly do and perform all things required to be done and performed by them in and by said "CONDITIONS OF APPRENTICESHIP" and the provisions thereof.

And, said party of the third part in consideration that the party of the first part has at .....request executed this AGREEMENT, covenants and agrees for ..... and .....heirs, executors and administrators, with the party of the first part that the party of the second part shall well and truly do and perform all things required to be done by him in and by this AGREEMENT, and "CONDITIONS OF APPRENTICESHIP" herein referred to.

In witness whereof, said party of the first part has caused duplicate copies of these presents to be signed and sealed by.....its.....for this purpose authorized, and said parties of the second and third parts have hereto set their hands and seals in duplicate the day and year first above written.

Signed, Sealed and Delivered
in the presence of

.....[SEAL]

.....[SEAL]

.....[SEAL]

.....[SEAL]

Cleveland, Ohio, ...19.....

This is to certify that.....

.....

has served his full term of apprenticeship in the works of The Warner & Swasey Co., and has completed the prescribed course to their satisfaction.

.....

Cleveland, Ohio,.....19.....

Received of The Warner & Swasey Co., the sum of one hundred dollars ($100.00) as gratuity, the same being in fulfillment of their agreement herein set forth.

.....

APPLICATION FOR APPRENTICESHIP

On this.....day of.....19....., I hereby make application for apprenticeship to the machinist's trade in the works of The Warner & Swasey Co. and agree to conform to the Conditions of Apprenticeship and to the rules governing workmen in their employ.

Name in full .....

Residence and address .....

Place and date of birth .....

Father or guardian's name.....

Father's birthplace .....

Father's occupation or profession .....

Are you in good health?.....

Do you use tobacco in any form? .....

Do you use intoxicating drinks?.....

Do you use profane language? .....

Is it your custom to attend church services?.....

In what city or town were you educated?.....

Did you graduate from a Grammar School?.....

Name of Grammar School and age when graduated.....

.....

Did you graduate from a High School?.....

Name of High School and age when graduated.....

How have you been employed since attending school?.....

.....

Why do you wish to learn the machinist's trade?.....

.....

.....

.....

.....

.....

AGREEMENT AND APPLICATION TO BE FILLED OUT BY THE WARNER & SWASEY COMPANY'S APPRENTICES.

APPRENTICE PAPERS

THE WARNER & SWASEY CO.,

Cleveland, Ohio, U. S. A.

CONDITIONS OF APPRENTICESHIP

An applicant for apprenticeship to the machinist's trade must be not less than seventeen nor more than twenty-one years of age, physically sound, of good habits and character, and must have received an education equivalent at least to that required for graduation from the Cleveland Grammar Schools.

Application must be made in person, and, if considered favorably, the candidate must pass an examination at the works of The Warner & Swasey Co., under the direction of the Superintendent. If the result is satisfactory, as soon as there is an opening, he will be notified to begin work, subject to the rules and regulations governing the employes of The Warner & Swasey Co. In order that his fitness for the machinist's trade may be rightly judged the first 1450 hours (about six months) of his service shall be considered as a trial term, which may, however, be terminated at any time less than 1450 hours if it is found that he is not well qualified for the work; and during his trial period, reports of his progress and general deportment will be made by the foreman under whose supervision he is employed, and submitted to the Superintendent on the first of each month. If found satisfactory at the expiration of the trial term, he shall be engaged as a regular apprentice, after he and his parents or guardian shall have signed in duplicate the within accompanying AGREEMENT (one copy being retained by The Warner & Swasey Co., and the other by the parent or guardian), and the 1450 hours which he has served shall apply on the total number of hours required for his apprenticeship.

The time of apprenticeship for those who have complied with the above conditions shall consist of four terms or period of 2900 hours each, and the rate of wages paid shall be as follows: for the first period, 4 cents per hour; for the second period, 8 cents per hour; for the third period, 9 cents per hour, and for the fourth period, 12 cents per hour.

Those who, in addition to the qualifications named above, shall be able to present a certificate of graduation from a Cleveland High School, or one of equal standing, and shall come well recommended by the principal, shall, because of the greater time which they devoted to study, serve an apprenticeship of but three terms or periods of 2900 hours each, and shall be paid as follows: for the first period, 4 cents per hour; for the second period, 8 cents per hour; and for the third period, 12 cents per hour.

During the entire term of apprenticeship written reports of the workmanship, fitness and general deportment of each apprentice, together with recommendations as to his future work, shall be made to the Superintendent on the first day of January, April, July and October of each year, by the foreman under whose direction he is employed.

It will be the endeavor of The Warner & Swasey Co., as far as possible, to give each apprentice an opportunity to acquire a practical knowledge of the machinist's trade; and it is expected that they will manifest evidences of ambition, not only in faithful and diligent work in the shop, but in the improvement of their leisure time at home by reading and studying such mechanical and engineering papers and other literature as will enable them to master theoretical as well as practical problems, thereby fitting themselves to hold positions of usefulness and responsibility.

The Warner & Swasey Co. reserve the right, at their sole discretion, to terminate their agreement with any apprentice for non-conformity to their rules and regulations, want of industry or capacity, indifference to duties, or improper conduct within or without the shop.

Each apprentice, upon completing the respective term or course for which he has entered, shall receive a gratuity of one hundred dollars ($100.00) and a certificate of apprenticeship signed by The Warner & Swasey Co.

APPRENTICE PAPERS OF THE WARNER & SWASEY COMPANY.

The care with which apprentices are selected by some employers is illustrated in this form, and in the application blank and agreement reproduced on the opposite page. In the original the Agreement and Application are the second and third pages of a folded sheet, the form above being the first and outside page.

To be filled out in Applicant's own hand writing and returned to

Allis-Chalmers Company, Milwaukee, Wis.

Application for position as ..... *Date* *190*

Salary expected ..... *Lowest Salary to start* .....

Country of birth ..... *When naturalized if of foreign birth, or date of first papers* .....
See note on back of this sheet.

General education .....

Technical education ..... *Age* .....

Line of special study .....

Date of graduation from technical school .....

Where now employed? ..... *Could begin work* ..... *days after engagement.*

Reason for wishing to make a change .....

PRACTICAL EXPERIENCE State whether Apprentice, Tracer, Draftsman, Salesman, Machinist, Helper, etc. If in charge of work, state position.	WITH WHOM EMPLOYED State: (Firm name, Address, Line of Business)	DATES EMPLOYED From	DATES EMPLOYED To	STATE RATES OF PAY RECEIVED To Insure Consideration of Application

The compensation paid to employees by the Allis-Chalmers Company for services, covers inventions, and the undersigned hereby agrees, in consideration of such compensation, that every invention pertaining to the business of the Company conceived or developed by him during such employment, is the property of the Allis-Chalmers Company, and he agrees to make assignment of such inventions to the Allis-Chalmers Company on request, the Company to pay the expense of securing the patents.

Signature of Applicant .....

(Note other side of this sheet.) *Address* .....

(OVER)

FORM FOR APPRENTICE APPLICANTS, THE ALLIS-CHALMERS COMPANY.

Some employers have tried the plan of offering a bonus of one to two hundred dollars at the end of an apprenticeship. Even under these circumstances a good many boys leave. The premium is too far away, and figures out but insignificantly when reduced to the hour basis. Others require a deposit from the applicant, sometimes payable in installments out of the weekly wages, which is returned at the completion of the period, perhaps with the addition of a bonus. This works better in keeping the boys, but restricts somewhat

NOTICE TO APPLICANTS FOR POSITIONS IN THE ENGINEERING AND MANUFACTURING DEPARTMENTS

Engineers and draftsmen, and tracers upon being promoted to draftsmen, are required to provide themselves with slide rules. Draftsmen and tracers are required to provide themselves with a satisfactory kit of drawing instruments and triangles. Tee squares, beam compasses, pencils, ink, erasers, etc., are furnished by the Company.

Smoking is not allowed at any time in any of the Company's Offices or Works.

Send with this application copies of such letters of recommendation as you may have. (Do not send originals.)

References as to ability and character:

If there is not sufficient room on front page for any statements which the applicant desires to make, they may be continued below.

NOTE:—Citizens of foreign countries who have taken out first naturalization papers in the United States will be given preference over those who have not.

Applicants for citizenship in the United States may apply to the Clerk of any Circuit Court or United States District Court.

The party seeking admission to citizenship must state under oath before a Court that it is his bonafide intention to become a citizen of the United States and to renounce his allegiance to any foreign power.

The above statement by the applicant is simply a declaration of intention and does not have the effect of renouncing allegiance to the government of his home country, which he does not do until he takes out his final naturalization papers after five years' residence in this country.

REVERSE OF THE ALLIS-CHALMERS APPLICATION FORM SHOWN ON THE OPPOSITE PAGE.

the number of available candidates. Making the deposit payable in small installments, together with a suitable bonus and a fair wage, seems to be the best combination so far worked out.

It is in the latter thing—the wage rate—that the greater part of the trouble really lies. The wages paid apprentices, compared with what the same boys might earn elsewhere, are usually absurdly small. Fifty to sixty cents a day is about all that is usually paid. It is a poor worker indeed that at the age of sixteen or seventeen

cannot earn eighty cents to a dollar a day in the factory shop. The payment of a fair wage seems to me to be a necessity if we wish to keep the boys; and this judgment is confirmed by that of nearly every one experienced in apprenticeship matters, so far as I have been able to learn.

The sum and substance of the whole question of keeping apprentices then seems to be this: pay fair wages, provide comfortable, or at least decent working conditions, and give suitable instructions so as to make the period as short as may be consistent with a thorough training, and hold out a suitable financial reward at the end.

And then, having kept the apprentice to the end of his term and made of him a pretty good mechanic, possibly even an excellent one, suppose he leaves the master who has been at all this expense? No doubt this happens, frequently perhaps. But something is to be said as to such a practice, if indeed it be general enough to be properly so called. In the first place, a good mechanic is entitled to the best wages, in *any shop*, whether it be that of his former master or another, which his abilities would command elsewhere. Offering him less in the expectation that he will long continue in such a job is neither good business nor good sense. Suppose the apprentice has been getting, say, $1.50 a day during the last year of his apprenticeship. If he is any good at all, he will certainly earn more than that. But having ordinary good judgment, he realizes that he is paying the difference between what he is getting and what he feels he actually earns, for his training and experience. Now, having become a journeyman, the former master offers him, say $1.75, or $2.00, or possible even more. Older workmen in the shop, very likely not a whit better mechanics, get, say $3.00 and upwards. In justice to himself ought the new journeyman to be content with this? Certainly the employer himself, in an analogous situation, would be actuated by no sentimental motives to continue in a course which means personal loss to himself.

Nevertheless many graduate apprentices do remain with their former masters under just such conditions. Several employers could be named who make a practice of paying their newly made journeymen very low wages, compared with those paid older journeymen, perhaps no better workmen; and who have no trouble in retaining the services of practically all of them. They stay partly because of the spirit of the institution, a spirit that permeates the apprentice with a feeling like that of the college man for his *alma mater*, and partly because they are well treated and have ample opportunities for advancement.

THIS IS TO CERTIFY THAT

_____

has completed his term of ____ years as an Engineering Apprentice with this company.

He has performed his work to the satisfaction of the company and is competent to follow the profession of

Electrical Engineering.

In witness whereof the company has caused these presents to be signed at Pittsburg, Pa., by its Vice President and Superintendent,

this _____ day of _____ A. D. 19__

Superintendent *Vice President*

CERTIFICATE ISSUED TO "GRADUATE" APPRENTICES BY THE WESTINGHOUSE COMPANIES.

Furthermore, merely as a business proposition, the apprentice is profitable in himself within a short time of his indenture—either that, or he is not worth keeping and training. Under present shop conditions an apprentice must have small capacity or ambition who does not within a year turn out enough satisfactory work to warrant

the wages paid, and by the time he reaches the end of his term, earn considerably more than the wages paid. If not, the employer certainly would be well rid of him before the apprenticeship is far advanced. Wherefore the feeling that a graduate apprentice ought, in gratitude to his master, to serve him for several years more at small wages, is wholly unwarranted, considered from the business point of view—however it may be from the sentimental.

Very likely the reader interested in a comparatively small establishment employing few men and therefore having room for few apprentices, raises the question of adapting the rationalized apprenticeship system to his own business. Perhaps his output is of such a nature as to give little opportunity for an all-round training, even if proper instruction could be arranged for.

A solution of the problem seems to be at hand in the co-operation of several such employers. By arranging for the transfer of apprentices to the several shops of the establishments concerned in the co-operative system, a varied experience would be open to the boys. Furthermore, by such a mutual arrangement, it would be possible to get the proper instruction, both theoretical and practical, without prohibitive expense. Doubtless much of the academic and theoretical instruction could be arranged for with schools or qualified persons outside the shops.

So far as is known to me, no such plan has been tried as yet; but there is no apparent reason why it should not be as successful as a system confined to a single large factory.

A careful study of apprenticeship systems throughout the United States with a view to the establishment of a system for a large manufacturing plant in the middle western States resulted in the formulation of the following terms, agreement, and record forms, which with possibly slight modifications would be suited to nearly any shop or works:

TERMS OF APPRENTICESHIP.

QUALIFICATIONS. Applicants for apprenticeship, to be considered, must be over sixteen years of age and must have completed a grammar school course or its equivalent. High, manual-training, and technical-school graduates will be preferred, and may have their terms of apprenticeship shortened and be given credits for subjects completed, at the discretion of the Superintendent of Apprentices. Applicants must present satisfactory evidence of good moral character and habits, and must not be addicted to the use of drink or cigarettes. The use of tobacco in the shop will not be permitted.

TRIAL PERIOD. No contract will be made until after ten weeks' satisfactory trial, which period may be applied on the first year of apprenticeship, at the discretion of the Superintendent of Apprentices.

CLASSES. Apprentices will be classified as follows: Core makers, Molders, Machinists, Pattern makers, Draftsmen, and General Apprentices. Each appli-

cant will be permitted, so far as expedient, to choose at the time of employment, the class he will enter. Transfers may be made later for good cause.

TERM. Four years will constitute the term of apprenticeship for machinists and pattern maker; three years for molders and draftsmen; two years for core makers; and five years for general apprentices. Time lost must be made up, unless lost through action of the employer, in which case it may be allowed to apply on the term. Aptness and rapid acquisition of skill, as well as previous experience and attendance upon schools designated by the company, will permit of a shortening of the term of apprentices at the discretion of the Superintendent of Apprentices.

AGREEMENT. After the trial period of ten weeks, if the applicant has been attentive, diligent, and gives promise of being a good workman, the employer will execute with him in conjunction with his parent, guardian, or other responsible person, an apprenticeship agreement covering the time of service. The employer reserves the right to suspend or discharge the apprentice for inefficiency, violation of the rules and regulations, or whenever for business reasons it may be necessary to close the shops or reduce the working force.

COURSES. The course for each class of apprentices will cover the theory and practice appropriate to it, and such additional academic or technical subjects as may be required. General apprentices will be expected to get a good working knowledge of the business as a whole, and will be assigned to the various shops and offices as may be expedient. Apprentices of the other classes will be assigned to different shops and kinds of work from time to time, as may be found desirable, usually about once in three months.

RULES. Apprentices shall be subject to all shop rules and regulations in effect in the shops where they may be at work. They will be in direct charge of a Superintendent of Apprentices, and will work under the foreman or instructor in the shop to which they may be assigned. They must be faithful and regular at their work, and must not absent themselves without permission except in case of sickness or similar unavoidable cause.

EDUCATIONAL. Apprentices will be required to attend night or other schools, or otherwise procure instruction satisfactory to the employer, and to acquire proficiency in the subjects that may be prescribed; and to present certificates from the proper authorities attesting such proficiency. They are also required to attend such lectures and courses as may be provided for their benefit from time to time. If attendance be required during working hours, the time will be regarded as working time, and paid for accordingly.

CERTIFICATES OF PROFICIENCY. Apprentices completing their terms to the satisfaction of the employer will receive certificates setting forth the kind of work in which they have had experience, and the proficiency attained. Apprentices leaving their apprenticeship before the end of the term, with the consent of the employer, may receive similar certificates.

WAGES. The wages of apprentices will be subject to change at the discretion of the employer. At present the rates per hour, for all classes, are as follows: first year, ———; second year, ———; third year, ———; fourth year, ———; fifth year, ———. Overtime will be paid in accordance with the regulations of the shops.

BONUS AND DEPOSIT. Each apprentice will be required to leave with the employer a deposit of fifty dollars (in the case of molders, forty dollars, and core makers, thirty dollars) as a guaranty that he will complete the term of apprenticeship; and such deposit shall be forfeited to the employer in case the apprentice shall fail to complete his full term, unless such failure be with the consent of the employer. The deposit may be made in installments of one dollar fifty cents weekly until the full amount is deposited. At the completion of the full term of apprenticeship the apprentice shall be entitled to the return of his deposit, and in addition to a bonus of twenty-five dollars for each year of apprenticeship in the class to which he belongs. If after two years of satisfactory service the apprenticeship be terminated by the employer (except for cause), or if it be terminated by the apprentice with the consent of the employer, a proportionate part of the bonus may be paid.

RECORDS. A permanent record will be kept of the progress, expertness,

and general behavior of each apprentice; and advancement or assignment to positions after completion of the apprenticeship, will be based upon this record.

* * *

APPRENTICE'S AGREEMENT.

This agreement, made this.....day of..... 190.., between ....., a corporation doing business in the city of....., State of....., party of the first part, hereinafter designated as the Company, and....., of....., State of....., party of the second part, hereinafter designated as the Apprentice, is to the following effect:

First: The Apprentice agrees well and faithfully to serve the Company as an apprentice for a period of....years in the art or trade of....., in accordance with the "Terms of Apprenticeship" hereto attached and made part hereof.

Second: The Company agrees to accept the second party as an apprentice in accordance with the said "Terms of apprenticeship," and undertakes to have him taught the art or trade above named by keeping him employed in its plant under competent supervision and instruction.

Third: The Company will pay the Apprentice as compensation for his services, such wages as it may from time to time determine.

Fourth: The Company reserves the right to discharge the Apprentice for violation of the aforementioned "Terms of Apprenticeship" or for any conduct detrimental to the interests of the Company; and to suspend or dismiss him (in which case a certificate of honorable dismissal will be granted) if the condition of business shall make it necessary to close its shops or curtail employment.

Fifth: The Apprentice agrees to deposit with the Company, the same to be withheld from his weekly wages until the full amount has been deposited, unless paid in a lump sum at the time of making this agreement, the sum of..... dollars, the same to be held by the Company as a guarantee that the apprentice will faithfully serve the full term of his apprenticeship. Such deposit will be returned to the apprentice at the completion of his term. Should he leave the employ of the Company without its consent before the expiration of the term of apprenticeship, the deposit shall be forfeited to the Company.

Sixth: If the apprentice shall well and faithfully complete the term of his apprenticeship and shall have in all respects complied with the terms of the aforesaid "Terms of Apprenticeship," the Company will thereupon pay him a bonus of.....dollars in cash. In case the apprenticeship shall be terminated by reason of accident, sickness or other cause not involving the discharge of the apprentice, the Company may at its discretion pay an equitable portion of the bonus.

Seventh: The apprentice agrees to accept the instructions, wages, and bonus as herein agreed upon, in lieu of any and all other rights, instruction, presents, or payments required by law to be made; and he expressly waives all right and claim to the same.

Signed and sealed this.....day of.....190...

.....
Apprentice.

.....
For.....

I hereby guarantee that the above named apprentice, ... shall well and faithfully perform the conditions set forth in the above agreement and the "Terms of Apprenticeship" attached thereto

.....
Parent, Guardian, or Surety.

ORGANIZATION AND ECONOMY IN THE RAILWAY MACHINE SHOP.

By H. W. Jacobs.

IV. STANDARDIZATION OF THE SMALL-TOOL EQUIPMENT.

Mr. Jacobs' series began in our issue for September last. The preceding sections have dealt thoroughly with the policy of standardizing the equipment, operations, and tools, and the results thus to be attained, and have followed this with the discussion of the balancing of the tool equipment of an entire railway. A concluding section next month will take up "Erecting-Shop Economies."—THE EDITORS.

IT needs no argument to point out that if the small hand tools, used with air motors and otherwise in the erecting shop and on the bench, are reduced to a uniform standard throughout the shops of an entire railway system, economies in either the purchase or manufacture of these tools will result. This standardization should exist, from the drift pins and chisels to the type of screw or pipe wrench decided upon.

It will often happen that the foreman of one shop will order a grade of steel for his chisels more expensive that there is need for, or that a boiler-maker foreman at another point will select some special high-grade round steel from which to make his flue rollers. At another point, machinists' hammers will be forged on stock order instead of being obtained through requisition and purchasing agent, although the home-made hammer is not of as good quality nor shape, nor nearly so cheap in labor as the purchased article. In this connection it should be noted, however, that it would be best for the railroad to " handle " its own hammers, as the usual handle furnished by the manufacturer is not satisfactory.

These small items here mentioned are not imaginary ones, but cases from actual experience, each representing in the aggregate thousands of dollars for the railroad in question.

Most railroads at the present day have standardized their beading tools, and furnish from their central tool rooms standard gauges by which to try these for each shop. There are other boiler-makers' tools which should be similarly standardized, such as flue rollers for use with the air motor, which should always be self-feeding; an illustration of these has been shown in the October issue. These when

standardized can be more economically manufactured in the central tool room than purchased from the railway-supply concerns, and can also be more promptly furnished on requisition. Another advantage of standardizing these tools is that all the rollers will be of uniform size for each type of flue rollers, and the other parts of the tool will be interchangeable and supplies can be more economically carried in stock and renewals made than is usually the case where each shop has an agglomeration of the various types of rollers purchased now from this manufacturer, now from that, many of them having the small rollers missing, necessitating special sizes to be turned to fit them. The economies in the cost price of these tools here cited do not take account of the much more serious wastes in the time of the men learning to use the different types of rollers and attempting to get satisfactory results from them. It is needless to point out that where a standard flue roller is adopted, a man once learning its use will always be able to handle it to the best advantage, even though he be transferred from one shop to another shop.

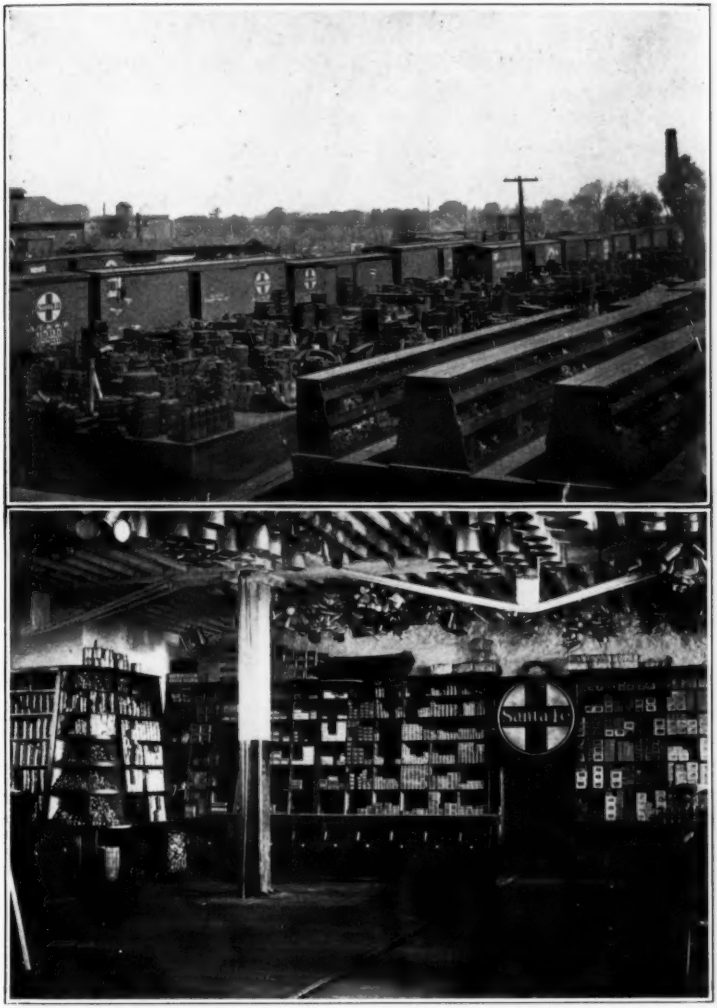
Another boiler tool that should be standardized is the set of taper plug taps. These should be made of standard diameter and taper and should be tried out by standard-thread gauge at each shop at least once a month. The economy in having such plug taps standard lies not so much in the economy of the initial cost of the tools themselves as in the lessened cost of finished plugs, manufactured at the central shops in large quantities and sent to outlying points on requisition. Similarly, staybolt taps should be standardized and inspected, enabling staybolts to be centralized in their manufacture, produced economically, and furnished to the outlying points as required instead of having each small shop turn up and thread its own staybolts as the requirements of some particular engine demand.

Chisels and beading tools lead to the mention of the special type of tools used with an air hammer. The shanks of these tools should be standardized and the hammer bushed to carry the standard shank.

Furthermore, a standard design of: (1) flat chisel; (2) cape chisel; (3) round-nose chisel; (4) diamond-point chisel; (5) ripping tool; (6) caulking tool, and one or two others, should be adopted.

The steps that have been here briefly indicated for the boiler tools are equally applicable to the erecting-shop and bench tools, to the tools of sheet-iron workers, tin and copper-smiths, and others.

The economies resulting in a general standardization of small tools over an entire railway will be considerable. It is worth while to pursue a systematic policy of collecting up all the spare tool equip-



STORAGE PLATFORM FOR FINISHED MATERIAL AT CENTRAL SHOPS, AND SHELVING FOR SMALL SUPPLIES, ILLUSTRATING THE RESULTS OF CENTRALIZED PRODUCTION OF SUPPLIES FOR A MODERN RAILWAY STORES ROOM.

ment, and this will necessitate the frequent inspection of all lockers to thin out the accumulations of pet tools carefully hoarded by selfish workmen.

The possibilities of saving in the wise selection and care of small tools used on the machines, are, however, quite as great as in the case of hand tools and probably play a more important part in effecting economical manufacture. The advantages of the new high-speed alloy steels over the old carbon and self-hardening varieties have been thoroughly explained within the last two years, and there is no need to dwell at length upon the changes that these new steel tools have wrought and are working in the machine shop of today and in the construction of the machines themselves. But the question was always raised as to whether these steels should entirely displace the older steels in the shops, as to the quantity of new steels it would be economy to purchase, and as to the method of disposition and custody of these expensive steels—and tools made from them—when purchased.

From an extensive experience with just this problem from the very first introduction of steels into railroad work, I should advocate with few exceptions that ALL the tools used on the machines—that is, on the planers, lathes, slotters and shapers, vertical and horizontal boring mills—should be replaced with high-speed tools. The permissible exceptions would be some of the finishing tools and possibly tools used on soft brass or on babbitt. This wholesale condemnation of the existing tool equipment is advisable both on account of its permitting a general speeding up of the machine tools and because of its securing standardization of size, shape, cutting edges, rakes, method of grinding, etc., of the machine tools, instead of leaving these important matters to the individual preference of the men. A few of the tools so displaced in one shop are shown in the article of this series in the preceding month. The usual practice in many railroad shops is for the mechanic to select the size bar he wishes a tool made from, and to stand by the blacksmith tool fire and supervise the hammering out and shaping of the tool to suit his individual taste. This practice results in many tools being far below the efficiency that should obtain, and is a source of great waste of the workmen's time; both of these disadvantages are overcome by the policy of centralized manufacture, from standard design, of all tools of this kind. In a shop of large size it is advisable even to carry this specialization of work on these tools to the regrinding in the tool room, instead of permitting the men to regrind them themselves.

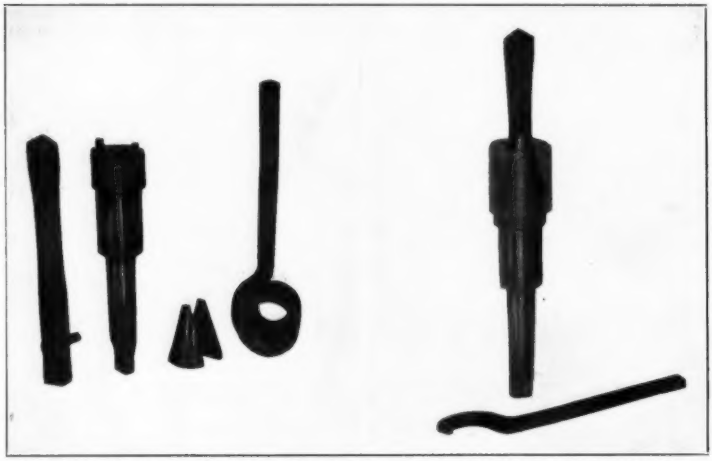
The view opposite illustrates a portion of a store house with such standard tools in stock to be furnished on requisition, each size of tool having its own shelf. It may be mentioned incidentally that the cutting edges are all ground to standard.

If with this system of centralized manufacture there is combined a supervision system whereby each local tool-room foreman keeps a list of each and every high-speed tool issued and checks the same over in the shop at least once a month, the greatest efficiency in tools will result, for the kind of tools best adapted for the work will be in service, and the smallest number for the output will be in use. The records will further serve to regulate the apportionment of tools, and by calling attention to certain needs of the department in the way of tool equipment, should prevent a haphazard and wasteful expenditure.

STOCK OF STANDARDIZED TOOLS IN A RAILWAY STORES ROOM.

Another way in which investment in high-speed steel can be kept at a low figure, and costs in the manufacture of tools be reduced, is by means of a special design of chuck for use with the high-speed steel flat drill. It has been shown by test and in practical work that a flat drill when properly shaped and ground is as efficient for drilling cast iron as a twist drill. Inasmuch as the cost of manufacturing a flat drill from plain bar steel is much less than that of machining a twist drill, and as a twist drill requires more material for the same size than a flat drill, it will be readily seen that in providing these tools over an entire railway system considerable savings are possible.

The accompanying illustration shows the chuck and its construction. In the first elements on the left are shown a flat drill with the pin that holds it in the Morse taper shank which stands alongside of it. Next are shown two detached jaws which hold the flat drill in place, next the collar or coupling, bored out taper, to be screwed down in place over them with the spanner wrench, also shown. The one on the right shows a phantom or "X-ray" picture of the drill in place in the chuck with the collar down.

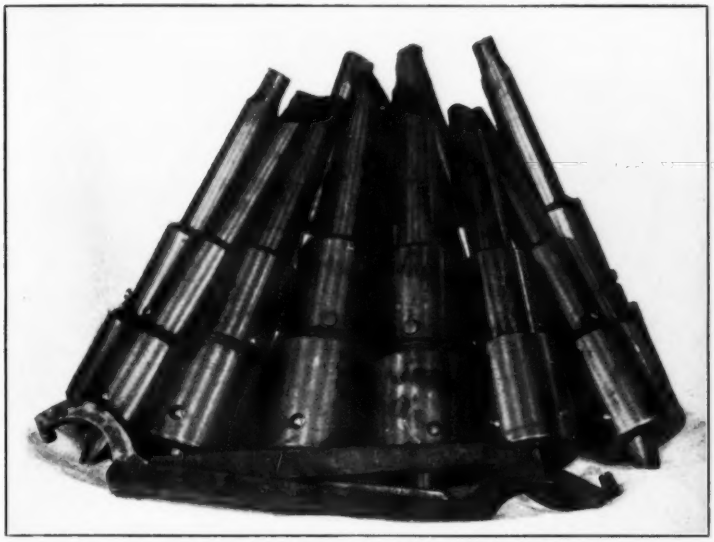


HIGH-SPEED FLAT DRILLS—COMPONENTS AND ASSEMBLED "PHANTOM."

The upper illustration on page 345 shows a number of these chucks as they are received finished from the tool room ready for shipment by the stores department to outlying points on the road. Each minor shop or round house is supplied with one or more of these chucks for use in the drill press, and a set of such high-speed flat drills as may be needed.

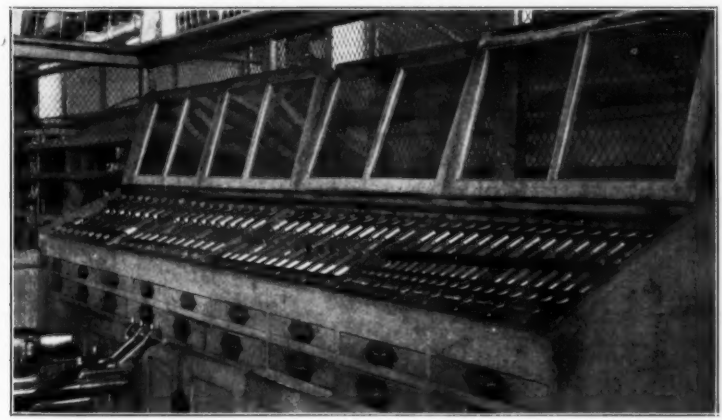
Functions of the Tool Room. Greater progress has been made by railroads all over the United States in the last four years in building new shops and equipment with up-to-date machinery, such as motor-driven machine tools, electric cranes, power plants, etc., than had been made in the previous twenty-five years.

But there is one department which has been overlooked, and is not up to the standard of a thoroughly modern manufacturing concern, and that is the tool room. By "tool room" is meant that part of the railroad machine shop in which all special reamers, taps, cutters, jigs,



GROUP OF DRILL CHUCKS, CENTRALLY MANUFACTURED.

templets, and measuring appliances, etc., are made, stored, and preserved in a satisfactory working condition. In addition to these functions, the average railroad-shop tool room takes care of all repair work, such as the repairing of all shop machinery, pile drivers, steam



STANDARD-GAUGE CASE, CENTRAL TOOL ROOM OF A LARGE RAILWAY.
Note the care with which the tools are surrounded.

shovels, snow plows, automobiles, computing and adding machines, electric and otherwise complicated locks, time-locks, pen-knives belonging to officials, etc., etc. In fact the tool room is a place where all odd jobs are taken. But this extra work can only be done at the expense of the regular tool-manufacturing. All of these odd jobs should come under a separate department, devoted to such repair work.

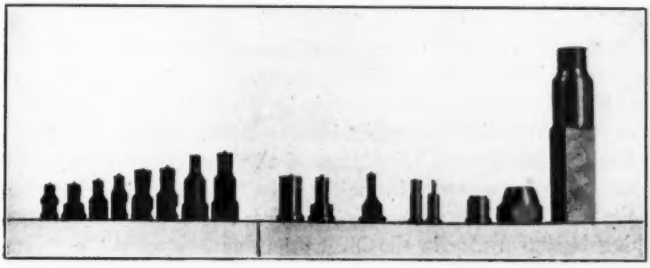
IDEAL (AND CHEAPLY CONSTRUCTED) INTERCHANGEABLE TOOL SHELVES IN A LARGE CENTRAL TOOL ROOM.

The advantage is that the tools take up the least space with reference to the ground that the attendant has to cover in selecting the size he wants. This is an important consideration in a large shop tool room.

In a broad sense it has been said that the prime function of the tool room is to act in the capacity of an arsenal to provide the management with the necessary weapons to wage war upon excessive cost; the word " excessive " is here used to indicate any excess of cost beyond that minimum at which it is possible to produce the article to be manufactured. Now and then a master mechanic tells us he has built and repaired engines without having any tool room connected with the shop. In days gone by, successful battles were fought with clubs, bows and arrows; but what chances would these same armies stand with a modern army equipped with modern weapons?

An aim of every superintendent of motive power is to obtain the most extensive output possible at the lowest cost, and the tool room is perhaps the most important factor in bringing around such a result.

The location of the manufacturing tool-room should be separate from the tool-storing and distributing department. The latter department should be located in the central part of the shop, to be within



NON-STANDARDIZED AND STANDARDIZED PUNCHES.

easy access of all workmen requiring tools. The tool-manufacturing part should manufacture for the entire railway system, thereby insuring an exact standard for all tools. Most railroads have the machine foreman run the tool room in connection with his own department; but this is a very grievous mistake, for the work requires a competent tool man, one who has had extensive experience in tool work and who has made this branch a special study; a man of this calibre cannot be had for 35 cents or 40 cents per hour.

To operate a tool room satisfactorily, at least one draughtsman should be associated with it to work in conjunction with the general tool-room foreman. He should keep a record of all tools made, and should control in a large measure the locating of tools, so that similar tools, either actually in stock or anticipated, may be grouped and numbered according to size, much after the manner of indexing and classifying patterns in well regulated shops.

In a previous section we dealt with standardized tools. In the illustration of punches on this page above it will be observed that the non-standardided punches are grouped at the left in black. These were only a few picked up in about fifteen minutes' hasty rummaging of a Sunday morning in one shop. It will be noted that each is of a different length, and of a different mode of fastening at the base; moreover that the diameters of the bases vary. The condition all over the whole railroad and the wide variety in style of punches used, can be guessed from this one example. The punches which are lighter in color are the standard ones. On the right is shown a stock which is made of such lengths and styles as will fit it to the particular machines. This stock

"PHANTOM" PICTURE OF STANDARDIZED PUNCH,

replaces the stock with which the machine is supplied by the manufacturer, and serves the purpose of enabling punches of standard length or height to be used in all cases. It will be noted that the upper end (lower when the stock is in place) is threaded to engage the hexagon coupling shown beside the stock. These couplings are all alike and consequently the bases of all punches can be made alike. In order to save material in making small punches, instead of turning these from a large bar they are turned from a small bar, and a bushing is shown also in the illustration, as used to bring the bases to standard size. The material thus saved comes to a considerable amount on a large railroad.

STANDARD PUNCHES, STOCKS, COUPLINGS AND BUSHINGS, READY FOR DISTRIBUTION FROM THE CENTRALIZED TOOL ROOM.

Economical Limits of Manufacture in Tool Room.—The problem of reducing time (cost) in the manufacture, repair, and assembling of locomotive parts is so intimately associated with the character of the tools and devices used in the different operations, that it is not logical to separate these two elements—the means employed to get work out, and the obtaining of maximum efficiency in the use of these means. For this reason I have always considered the design of tools and jigs of paramount importance, as the method determines in advance the time limit for the job; while the matter of keeping the men near this minimum is a matter of discipline of men rather than of intelligent direction of work.

For this reason also a railroad shop cannot without direct loss avoid manufacturing a considerable proportion of tools applicable only to the peculiar design of certain locomotive parts. Even if these tools could be purchased from the manufacturer for less than their cost in the local shop, it would be of doubtful economy to order them as the making of detail drawings and specifications and the loss resulting in work from delay in putting new methods into effect, as well as the disadvantage of not having supervision and inspection of the tools

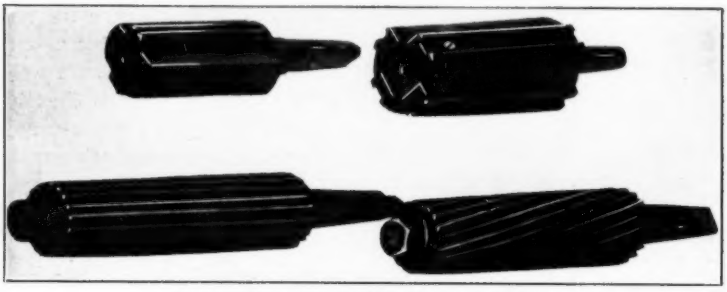
during their manufacture, would more than counterbalance the reduced price. But as a matter of fact, tool-manufacturing concerns are no better equipped for handling special designs of tools than a well planned railroad shop, the ability to turn out such articles cheaply depending upon the experience of the men in charge of the work, and not upon the machines, which are much the same under both conditions. If, however, the tools are not produced under intelligent direction, it will not pay for a railroad shop to undertake their manufacture.

A good illustration both of the economy secured by thought and experience in the initiation of quick and accurate methods in locomotive work, and of the wastefulness in having tool manufacture undertaken by persons unfamiliar with the subject, is the following.

The idea was to standardize work on crosshead fits, everything to gauge instead of continuing the old hand fit. On compound engines, the piston rod works loose in the crosshead, and wears the hole oblong. To true out these holes the crosshead has hitherto been put in a machine and been bored out. With the reamer that was made for this purpose, it was impossible to ream out these steel crossheads, as the reamer was not properly designed for this class of work, the flutes being straight, and gouging into the work, thereby stalling the machine and breaking off the end of the shank. Therefore, the truing up of these holes was done in a boring mill, and took about six hours. More often, though, the holes were let go, not being trued up, and piston rods were fitted to them in this state.

Necessarily the life of a rod so fitted would be only one-half the life of one that has been fitted up to a hole that was properly trued. With the present standardized reamers, the man on the boring mill reams out two holes per hour. On one hundred and twenty compound engines going through a main shop in a year, four holes being reamed on each engine, there is in crossheads, in reaming out crosshead-pin holes, in piston heads, a saving in all of over $1,700. Owing to cruder methods, the same work is even more expensive when done at other points than at the main shops. These figures do not take account of the losses in life of piston rods.

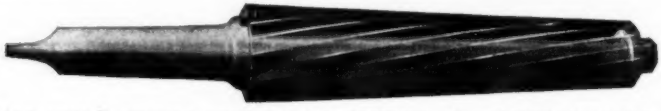
The next illustration shows the evolution of the crosshead and piston-rod reamer from a rough contrivance of wood and brass to a modern one made of high-grade steel, with spiral flutes, in two sections, hollow for the purpose of even cooling in the tempering process, and with soft-steel arbor. The crosshead reamer is extensively described in the "economical limits of manufacture in tool rooms."



EVOLUTION OF THE CROSSHEAD REAMER.

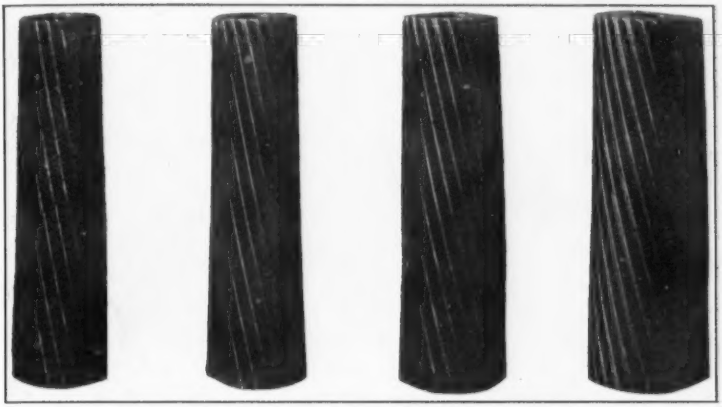
The working out of the details of this standardization was left to the mechanical engineer and the general tool foreman. It was determined in advance what shops were to be supplied with the reamers, and eight extra blanks were provided in case any reamers were spoiled in the making, or additional reamers required. A first-rate quality of tool steel was ordered so as to prolong the life of cutting edges and keep down the maintenance and high item of grinding a reamer of this character.

At the time the drawing was made, it was proposed to state the material and details of design of reamers and arbors; but it was finally decided to leave these matters to the judgment of the tool-room foreman.



"PHANTOM" PICTURE SHOWING CONSTRUCTION OF CROSSHEAD REAMER.

The labor costs were made as low as they proved by applying commercial methods in the manufacture, doing each operation on all the blanks at once. From the time the material arrived to the date the reamers were shipped to their respective destinations was three months, not interfering with regular tool-room work. However, as the general tool foreman left the tool room shortly after the work was started he could not continue to give the matter his personal attention. In consequence, upon his return he found that in applying arbors, six of which had already been made of machinery steel, the acting foreman over tool-room work had already used a steel at 46 cents a pound for these arbors instead of machinery steel at 3 cents, entailing the needless expenditure of $240. The more expensive steel



FOUR MODERN STANDARD CROSSHEAD REAMERS.

All standard taper, enabling piston rods at the piston and crosshead fits to be made taper to gauge.

is not so fit for the purpose used, being more brittle. It should not be possible for mistakes of this kind to occur, and some method should be devised for checking up tool work, so that it may be properly directed. Unless specific instructions are issued covering all details of importance, too much leeway is left for making individual variations in the work.

Many benefits would accrue from having an efficient inspection system, including statements of labor and material on each order for all new work manufactured in shops; the tool room would be an excellent place to begin this inspection system, if it is proposed to carry on the manufacture of tools there on an extensive scale. In this way it is possible to oversee all this work, and by comparison with requisitions for purchase of new tools, determine just what tools to purchase and what to make in the shops. With this would be included the checking over of all store orders for new tools, and also the gathering of data of costs of making various tools in the shops, and the corresponding manufacturers' prices.

THE YORK TIN REGION OF ALASKA.

By Frank L. Hess.

Our readers will recall Mr. Hess's article in our October issue, describing the Carolina tin deposits. The region reviewed in the following pages stands next in current interest, so far as American prospects for tin production are concerned; and as in the preceding case, Mr. Hess writes from recent personal examination and study of the ground.—THE EDITORS.

THE York region may be defined, in a general way, as a triangular area with its apex at Cape Prince of Wales, in longitude about 188° 5′ west, from which point it extends eastward to about longitude 166° west. It is bounded on the north by the Arctic Ocean and on the south by Bering Sea and Port Clarence. The settlement called Tin City is situated on Bering Sea about 5 miles from Cape Prince of Wales. Buck Creek is about 14 miles and Ears Mountain about 55 miles east of the cape. The Lost River deposits are about 25 miles, and York, a collection of a few cabins at the mouth of Anikovik River, about 10 miles southeast of Tin City.

From Nome, the center of population, trade, and mining in the peninsula, boats sail at frequent intervals during the open season to the mouth of Lost River, York, and Tin City, while boats going to Kotzebue Sound will land persons who wish to reach Ears Mountain from the Arctic coast side, at Shishmaref Inlet.

Topography.—Between the York Mountains on the east and Cape Mountain on the west there is a table land rising to an elevation of about 600 feet. This table land, known as the York Plateau, is an old marine bench which is now dissected by streams and above which occasional hills rise higher than the general level.

East of the York Plateau are the York Mountains, steep-sided and sharp-ridged, composed largely of limestone and frequently almost bare of vegetation. Through them the streams have cut their channels to comparatively low grades. About 16 miles north of York, Potato Mountain rises to 1,370 feet, while to the west Cape Mountain, an isolated mass with steep sides and cliffs of granite exposed to the wash of Bering Sea and Strait, reaches 2,300 feet.

Along the Arctic shore there is a broad, low tundra with fringing spits, behind which are shallow lagoons, the largest of which is Lopp

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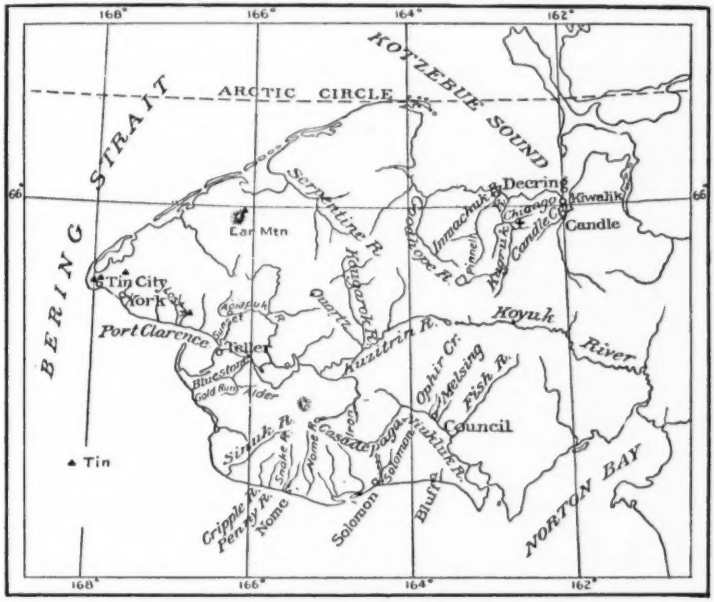


SKETCH MAP OF THE SEWARD PENINSULA.

Lagoon. Over the flat, or tundra, are scattered almost innumerable ponds and lakelets. From the shore the land gradually rises to the hills from 6 to 16 miles back.

The streams of this watershed are the longest of the region, but their grade is low and their course across the flats is tortuous.

Geology.—In a general way, the rocks run across the York region in broad north-to-south bands, intruded by greenstones, granites, and some more basic rocks. East of a line running approximately northeast from the mouth of Kanauguk River to the Arctic plain the great mass of rocks is of limestone, generally thin-bedded, which seems to be of Upper Silurian age and is known as the Port Clarence limestone. Between York Creek and Mint River is a large area of slates, of unknown age, in the south end of which is Brooks Mountain. West of the limestone is an area of sedimentary rocks varying from graphitic slate to fine-grained false-bedded quartzite. This slate extends from the Kanauguk to a point about 5 miles east of Tin City, where it is succeeded by Carboniferous limestone, apparently overlying the slate.

Cape Mountain is a mass of coarse, gray porphyritic granite thrust through the limestone, and into the latter acidic dikes and sills have been intruded in all directions. There are also later basic dikes cutting both limestone and granite.

At Brooks Mountain, Ears Mountain, and Tin Creek are large intrusions of granite, while granite dikes cut across Lost River valley at many places and are also found on King River and in the slate area between Don and California rivers.

Greenstone dikes, probably altered diorites or still more basic rocks, cut the slates at a number of places in the vicinity of York, and basalt or diabase dikes are known on Cape Mountain and along Lost River.

The alluvial deposits are generally shallow, 5 or 6 feet being ordinarily the maximum depth of the stream gravels. The depth of the gravels of the Arctic tundra is unknown.

Tin Deposits.

Lodes. Lost River Area.—The first discovery of lode tin in Alaska was made in the summer of 1903 on Cassiterite Creek, a tributary of Lost River, about 7 miles from the sea, by Messrs. Leslie Crim, Charles Randt, and W. J. O'Brien. A small amount of prospecting was done that year, enough to show that the tin ore occurred in a much metamorphosed acidic dike. The property was bonded, but reverted to the owners the next year (1904). During 1904 and 1905 prospecting continued; several more dikes carrying cassiterite were found, and several veins in the limestone were discovered.

Should the lode deposits be shown to carry sufficient values to pay for exploitation, they will have many advantages over placer deposits, for they can be operated the entire year, while placer deposits can be worked only during the short open season and even then there are frequent delays and inconveniences from storms, floods, lack of water, freezes, and other hindrances. Lode mining, being under cover, can be carried on without regard to weather.

Geology.—The entire Lost River basin lies within the Port Clarence limestone. About a mile from Lost River, on Tin Creek (a tributary of Lost River, 5½ miles from the sea), is a large boss of granite, half a mile in diameter and 1,000 feet high. Many acidic dikes cut the limestone, radiating in a general way from this boss, though but few can be traced directly to it. The dikes are usually but a few feet wide, 18 inches to 25 feet being the approximate limits, with local widening or narrowing.

Ore Bodies.—Up to the close of 1905 the only known deposits of cassiterite were on the Crim, Randt, and O'Brien group of claims, and one other, Discovery claim, on a dike known as the Dolcoath lode. The Crim, Randt, and O'Brien deposits include those originally discovered and several veins and tin-bearing dikes found since. The original discovery was on a rhyolitic dike, called the Cassiterite lode, running from Cassiterite Creek across the mountain eastward to Tin Creek, a distance of about a mile. Tin ore has been uncovered at a number of places on this dike near Cassiterite Creek.

By stripping the débris, 3 to 10 feet thick, another dike, or a branch of the one described above, was uncovered about 100 feet to the south. The dike was laid bare to a width of 25 feet, but its full thickness was not reached. The rock is much decomposed, but as it is frozen its removal requires much drilling and the use of dynamite. Drilling in such rock is easy, but, like frozen ground, it is "short" in blasting and picking is slow and tedious. The dike is of the same rhyolotic character as the one in which the original discovery was made and contains inclusions of a darker intrusive, also much decomposed.

Several small tin-bearing veins were found in the dikes, varying in width from 1 to 2 inches, and occasionally widening out to form vugs almost entirely filled with beautiful dark cassiterite crystals embedded in fluorspar and zinnwaldite (a lithia-iron mica). The vein matter is largely zinnwaldite and the only enlargement seen by the writer was apparently about 2 feet in diameter and probably at the crossing of two veins. Some wolframite is found in the tin veins, though in small amounts. A few feet south of the tin veins there are two small veins of molybdenite, ¼ inch to 1½ inches thick. The molybdenite is in masses of small scales, accompanied by fluorite and mica. No tin was seen in these veins.

A prospect cut in the bank of the creek exposed the same dike carrying a small amount of tin. A stream-cut bench 3 to 4 feet above the present creek bed, covered with 3 feet of gravel overlain by about 8 feet of débris, was also exposed. The gravel carries angular crystals of cassiterite and from the ease with which it can be handled would probably pay for working in a small way. To judge by the contour of the surface, the gravel deposit appears to be a quarter of a mile long and 50 feet wide.

A dike known as the Ida Bell lode is on the west side of Cassiterite Creek just above the Cassiterite lode, and is believed by the owners to be an extension of the latter, although this does not

seem proven. Instead of being one dike it is really three that have come up through the same fracture. The middle 5 or 6 feet of the mass is a white rhyolite, while on each side is a smaller dike from 2 to 3 feet wide of a badly decomposed gray granitic rock. The dikes strike N. 50° W., with a vertical dip. A tunnel has been run about 100 feet along the east side of the dike, with a crosscut about 50 feet from the mouth. Some tin is found along a horizontal fault on the east side of the dikes and more is said to have been found at the end of the tunnel. Quartz veins an inch or less wide, carrying wolframite and probably some tin, occur in a silicified portion of the dike about 66 feet wide, 50 feet from the mouth of the adit.

About 500 feet north of the Ida Bell lode is another dike of rhyolite, which resembles that of the Cassiterite lode, and is called the Bear lode. It has an east-and-west strike, and on top of the hill between Cassiterite Creek and Lost River is about 35 feet broad. A tunnel about 55 feet long was run into it from the creek level and a winze sunk 69 feet along the west or hanging wall. This was filled with water, so that it could not be entered. It was said that many small tin-bearing veins were found running in various directions, most of which were near the middle of the dike. Fragments of rock in the dump showed veins of almost pure cassiterite and quartz about ½ inch thick, and other veins carrying cassiterite, chlorite, and some wolframite up to 1½ inches thick.

At the creek level the dike is much decomposed and considerably iron-stained. Where exposed on the top of the hill it is hard and shows no tin. About 275 feet to the north, along the top of the hill, there is a similar dike, 6 feet wide, striking N. 60° W. No tin has yet been found in it. It is noticeable that no tourmaline has been found in these deposits.

The Dolcoath lode is a narrow dike about 2½ feet wide, 1 mile N. 15° E. of the Cassiterite lode. It strikes N. 70° E. and dips 65° NW. A crosscut on the Discovery claim showed the dike to be about 2½ feet thick. On the hanging wall is a deposit from 6 to 12 inches thick of arsenical and antimonial pyrites mixed with feldspar. The feldspar carries some cassiterite, which also occurs in calcite and impregnates the limestone. About 400 feet to the east the dike matter has been entirely changed and shows only light-colored orthoclase-feldspar, quartz, and tourmaline. In places in the limestone on the foot-wall side of the dike cassiterite forms a vein 4 or 5 inches thick. There are signs of faulting in the veins, and joint planes run from the limestone across the dike. An assay of the feldspar-quartz-tourmaline

portion of the dike is said to have given 1.15 per cent of tin. Tin ore is also reported to have been found in float on the same dike at its outcrop near Lost River. The mineralization has been very great, but has taken place in a comparatively restricted area, especially that part which shows cassiterite, and in this fact lies the greatest ground for doubting the future development of large tin deposits in this district.

Three known tin-bearing veins of noticeable and possibly workable size occur in the limestone. There is a quartz vein about 4 inches wide dipping 30° S. an eighth of a mile above the Cassiterite lode, on what is known as the Jupiter claim, but it has been traced only a short distance. The limestone is much metamorphosed for about 4 feet on each side of the vein, and is somewhat impregnated with cassiterite, though to what extent is not known. During 1904 a few tons of ore were extracted from this vein and shipped to Seattle.

Another vein occurring a few rods northeast of the one just described is about 4 inches thick, strikes N. 20° E., with a vertical dip, and has been traced between 200 and 300 feet. It is composed of slender quartz crystals forming interlocking combs. On the quartz crystals and sometimes embedded in them are small crystals of cassiterite, occurring singly and in small masses, showing that more of the cassiterite was deposited in the later than in the earlier stage of the vein formation. Some of the crystals are beautifully iridescent. There are traces of copper and wolframite, and a small amount of lithia mica occurs in the vein.

On the hill between Lost River and Cassiterite Creek is a third vein about a quarter of a mile southwest of those already described. It is from 1 inch to 6 inches thick, dipping 30° S. 10° W., and has been followed by an open cut about 30 feet along the strike and 10 feet along the dip. The quartz and cassiterite are rather finely crystallized and fill the vein with a banded structure. There is also a small amount of iron pyrite, arsenopyrite, and lithia mica, with occasional copper stains in the vein.

The limestone is much altered for several feet on each side of the veins, and whether they will pay to work seems to depend largely on how much tin is carried in the altered limestone accompanying them. Should the dike deposits be mined, at least the first-described vein would probably pay if worked in connection with them. There seems little doubt that these veins can be traced to the rhyolitic dikes in the neighborhood.

No tin-bearing veins have yet been found in Tin Creek valley, although some float tin ore is said to have been found. Pyritiferous

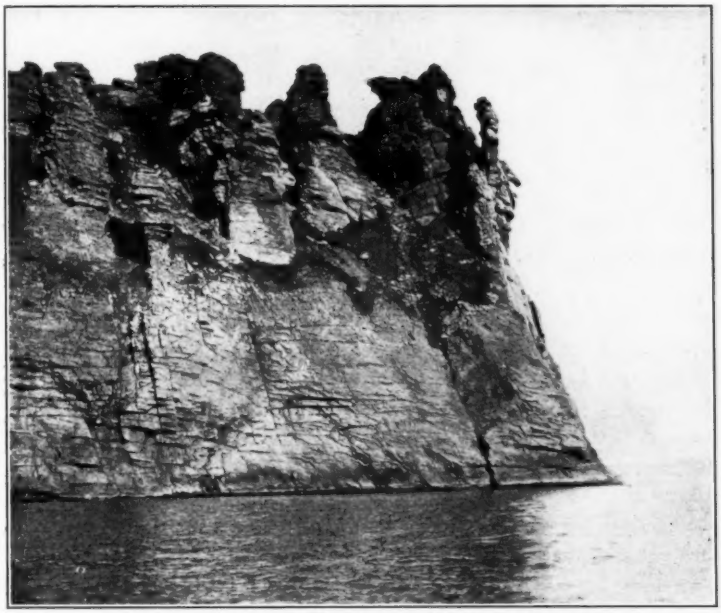
PANORAMA OF CAPE MOUNTAIN AND SURROUNDING HILLS, FROM THE SOUTHEAST.
Cape Mountain is the highest point in the picture.

granite collected here has been shown to carry a small amount (0.3 per cent) of tin, but whether as an oxide or sulphide (stannite) is not known.

Cape Mountain Area.—On Cape Mountain prospecting for tin has been carried on since 1902, and a large amount of work has been done, especially by the Bartells Tin Mining Company. It is a particularly bleak, inhospitable portion of the country, and the determination and endurance of Alaskan prospectors is exemplified in the men who are attempting to open the tin mines in this district; this applies with equal force to Buck Creek and only in a less degree to Lost River. Fine pieces of float tin ore made up of quartz, tourmaline, and cassiterite were found at many places in the vicinity of Cape Mountain, but it was not until 1904 that the ore was found in place. During 1905 there were further discoveries of tin ore that made the outlook more encouraging.

Geology.—As has been stated, Cape Mountain is a large mass or boss of granite, thrust up through

Carboniferous limestone. It is 2,300 feet high, about 5 miles across in an east-west direction, and something less north and south. The upper 400 to 450 feet of the mountain is a dark quartz-sericite-schist, separated from the granite by 10 or 12 feet of thin-bedded limestone in alternating dark and white bands an inch or two thick. From the main mass of the granite, dikes and sills varying greatly in size cut the limestone in all directions.



DETAIL OF ROUGH POINT JUTTING INTO BERING SEA.

The point is on the left of the picture opposite, and shows the intense jointing of the granite

Basaltic dikes, from 3 or 4 feet to 30 feet in width, cut both granite and limestone. The rock is fresh, black, and hard, and is accompanied by little contact alteration. The basalt seems to be later than the tin deposits, and so it is not likely that any tin will be found in connection with it except as it may happen to cut across tin veins or tin-bearing rocks. The granite is very much jointed, the two most prominent series of vertical joints running N. 60° E. and N. 50° W., while many lesser joints run in directions between these. A system of almost horizontal parallel joints gives the granite a platy structure in places. Other joint planes are inclined at various angles.

THE SNOW BRINGS OUT IN HIGH RELIEF THE GRANITE PILLARS OF THE BENCHES.
The cabins in front are Tin City, Bartell's tin mill is on the right. The foreground is the frozen surface of Bering Sea.

The two main series of joints cause the granite to weather into numerous columns left standing upon the shoulders of the mountain, giving them an appearance of being capped by rows of ruined factory chimneys. These columns vary considerably in height and thickness, reaching a height of 30 feet with a base of about 4 by 8 feet.

Faulting is very frequent, and although the amount or direction has not been determined the accompanying crushing is sometimes considerable. One mile west of Tin City, at the contact of the limestone and granite, there is a crushed zone 4 feet in width along which a tunnel has been driven about 80 feet to prospect a sill of alaskite that carried some pyrite and tourmaline. Assays are said to have given values of from $2 to $180 per ton in gold, but these values did not last as the tunnel advanced. In other places in the area faulting and crushing have produced almost as great an effect, and these factors introduce a serious element of doubt in tin mining, for, as will be seen later, the tin veins are affected by the faults.

Tin Deposits.

Float cassiterite has been found quite extensively near Cape Mountain. It is reported from the vicinity of Cape Prince of Wales, and a fine piece weighing several pounds is said to have come from a point about 12 miles east of the cape. Little has been seen on the south side of Cape Mountain, and by far the largest amount has been found on the north and northeast sides, where masses of nearly pure

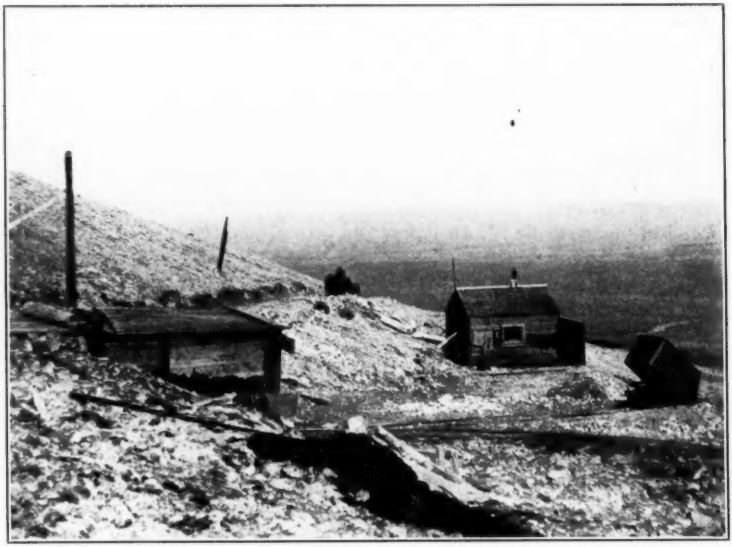
cassiterite weighing from 20 to 30 pounds have been picked up. The float indicates three distinct sets of veins—veins of cassiterite with tourmaline and quartz, tin-bearing quartz veins, and veins of almost pure cassiterite. The latter apparently cut the limestone, but had not yet been found in place when visited. Fragments of the first-mentioned are much the most plentiful and are distributed over the largest area; the other two, so far as known, have each been found in but one locality.

One noteworthy feature is the distinctive character of the ore from different parts of the area. As soon as a little familiarity with the different claims is acquired it is easy to tell the particular locality from which specimens have come by their color, crystallization, etc.

The plant of the Bartells Tin Mining Company includes an assay office, storerooms, engine, and living rooms under one roof at Tin City. A gasoline engine furnishes power for electric drills used in mining, to which the current is carried about a mile across the mountain by bare copper wires. The electric drill seems peculiarly well adapted for work in this region. It is mobile, although a track is required for moving the motor accompanying each drill, and in such prospecting work as has been carried on here it has been a great advantage to have a central plant at headquarters near the shore. Another advantage is that the cold of the tunnels does not affect it, while air pipes would probably soon become clogged with ice, and steam could not be considered. A three-stamp Merralls mill with Wilfley tables has been erected, and a well to obtain water for winter working was sunk near the shore. During the past season the mill was started and a shipment of concentrates was to be made this fall.

Prospect tunnels and shafts have been dug at numerous places and a large amount of work has been done upon them. In 1904 some small tin-bearing veins were struck in a prospect tunnel known as the "Lucky Queen," about 1½ miles north of Tin City. This tunnel was unused and largely filled with ice in 1905, and the principal operations of the company had been transferred to the North Star claim, lying a short distance east and at a somewhat lower altitude. These two tunnels are located well toward the east end of a granite mass that seems to be a large dike, though time did not admit of tracing out its relations, and it may be a portion of the main mass of granite over which enough limestone still lies to cover its larger proportions. Another prospect tunnel that is said to cut through a small thickness of limestone before striking the granite has been started 150 or 200 feet below the North Star tunnel.

By far the largest and most promising prospects so far found are in the North Star, which was driven into the granite a little over 200 feet in a general direction of about S. 70° W. Older parts of the workings are hard to examine owing to their being covered with a beautiful coating of frost from one-half to 1 inch in thickness. The frost is said to form noticeably only during the summer, when the air from the outside brings in moisture which forms in bristling feathery crystals over every object in the mine. Near the entrance the surface water dripping from the roof forms icy stalactites and stalagmites that later grow together, making gradually thickening pillars, which, unless removed, choke the tunnel.

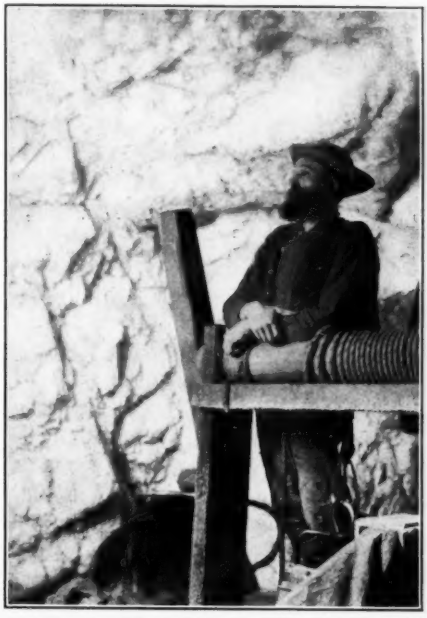


ENTRANCE TO NORTH STAR TUNNEL.

A short distance from the mouth of the tunnel a large limestone inclusion was passed through, which formed the upper 4 feet of the tunnel for a distance of about 28 feet. Faulting was evident along the edges of the limestone. About 100 feet from the mouth of the tunnel another inclusion of limestone was struck that was in a broad band 10 to 20 feet thick, striking about northwest and dipping variably northeast. Along both sides of this limestone was a considerable amount of iron oxide, carrying some tin. The contact of the limestone and granite was followed to the northeast about 52 feet, where the dip became almost vertical. A winze was sunk 20 feet,

when the dip became gentler (17°), but 70 feet from the winze the contact dips 37°.

From the foot of the winze an incline with its floor on the limestone has been run about 90 feet, parallel to but in the opposite direction from the main tunnel. Tin-bearing veins were struck at several places along the course of the incline and drifts turned off at two places. One of these 60 feet from the winze is 18 feet long, turning to the north and then to the east, and is said to carry pay ore, but had not been systematically sampled. The second drift, 70 feet from the winze, turned southward under the main tunnel. At the point of turning 3 feet of rock carrying a large amount of cassiterite was encountered. When thawed, the rock fell to pieces, being finely crushed through the whole width. This particular place seems to be the junction of a number of faults which carry but little gouge and whose character and extent are unknown. Near the faults the granite is sometimes much changed, having lost most of its feldspar, which is replaced by quartz, black tourmaline in very fine crystals, and varying amounts of cassiterite. Tin-bearing granite was struck at a number of places in this drift, but the distribution seemed irregular. About 20 feet from the mouth another and by far the most promising ore body was found. This ore body follows a vertical fault with from ¼ inch to 1½ inches of gouge, striking as nearly as could be determined, N. 56° W., and was formed by the replacement of the granite, through a space of from 12 to 18 inches on each side of the fault, by quartz, tourmaline, cassiterite, feldspar, and a now decomposed mineral in long, white crystals. The whole vein averages between 2 and 3 feet in width and appears almost diagrammatic against the



FROST ON THE WALLS OF THE NORTH STAR WORKINGS.

surrounding granite. Replacement of the granite seems to be complete and the mineralizing solutions evidently came up along the fault. The various minerals show an apparent tendency to segregate, and this applies particularly to the tourmaline and quartz, while the cassiterite is more apt to be associated with the quartz than the tourmaline, although there are generally needles of tourmaline running through the cassiterite. The tourmaline in irregular bunches of slender black crystals, from 6 to 12 inches in diameter, occurs either next to the fault or surrounded by other minerals. The cassiterite associated with the quartz forms irregular masses and bands through the body. As elsewhere around Cape Mountain, the granite is greatly jointed and both tin ore and tourmaline extend to a joint and apparently stop abruptly, the rock beyond the joint showing very different characteristics.

Little that is definite can be said of the richness of the deposit, as it was struck only the day before I left the vicinity and it had not been sampled, but it appears promising. It is reported that work during the next few days showed the ore body to be increasing in richness. From the appearance of the vein, its width and amount of mineralization, and the known depth of tin veins in other parts of the world, it seems reasonable to expect that it will extend downward, unless faulted off, a fear from which one can not escape in such broken rocks. Some tin ore was found in the main tunnel 30 feet above, which may have been the same deposit, though at that point the vein is said to be small.

About 1 mile north by west from the North Star and 2 miles northeast of Cape Mountain a large amount of excellent float tin ore has been picked up in the vicinity of a granite sill in the limestone on the Walker, Lovell & Co. prospects. Lumps of the ore have been found that were estimated to weigh 400 pounds or over, of which by far the larger part was tourmaline. A cabin has been built and a prospect tunnel run into the limestone nearly 100 feet at this point, and about a quarter of a mile north-by-west an open cut made which uncovers two thin sills, one of aplite carrying small crystals of fluorspar and one of coarse pegmatite. The sills are accompanied by about 3 feet of a fine-grained greenstone, which is probably altered limestone. It is said that assays of this greenstone made in Nome gave about 1 per cent of tin, but tests by E. C. Sullivan, of the United States Geological Survey, failed to show a trace of tin.

About half a mile east of Walker, Lovell & Co.'s cabin Goodwin and Carlson had run a prospect cut along the contact of a granite

dike with the limestone country rock. Faulting is evident, there being 2 or 3 feet of crushed rock along the contact. The granite carries some fluorspar and brassy-looking pyrite.

Some good float of dark, translucent cassiterite in a ground mass of light-blue tourmaline in pieces ranging in size to over a foot in the longer dimension, was picked up, but none was seen in place. Later its discovery was reported and about half a ton of ore similar to that described was brought to Nome.

The United States Alaska Tin Mining Company has a cabin and a couple of small warehouses on the beach at Tin City and has started a 10-stamp mill a quarter of a mile back from the beach. Power is to be furnished by a gasoline engine. The claim on which the company is at present working is situated on the north side of Cape Mountain, at an altitude (barometric) of about 1,750 feet. A shaft sunk on this claim is said to be 15 feet deep, but was filled with water so that it could not be seen at the time it was visited.

Along the side of the hill on each side of the shaft are a large number of quartz blocks, some of which contain cassiterite in almost colorless, gray, brown, and black lustrous crystals. No other minerals are seen in the quartz. The granite country rock in the shaft is somewhat altered and is said to carry tin. A specimen said to be from this place shows cassiterite crystals.

A contract was let in the fall for 300 feet of tunnel to be run during the winter from a point lower down the hill in the hope of cutting within that distance the vein from which the quartz float is derived.

Prospecting has been or was being done at a large number of other places. It was said that float tin ore had been found nearer the cape and some prospecting done, but the locality was not visited. At another point a dark basic dike was being prospected by a crosscut, but in such rocks the chances of finding tin ore are small.

Buck Creek Area.—So far no producing tin lodes have been found in the Buck Creek area, but it is of interest that several small tin-bearing veins were found during the season.

The country rock is slate, and outcrops of igneous rocks had not been seen, although it was felt that there must be such occurrences; but a number of granite dikes are now known at various points in the hills running northward from Potato Mountain. A number of narrow veins of quartz 2 or 3 inches wide carrying small clusters of cassiterite crystals accompanied in each case by iron pyrite, generally more or less arsenical, have been found cutting the slates on these hills. The pyrite weathers away, leaving the cassiterite in spongy spaces in the quartz.

On a hill west of North Fork of Buck Creek a granite dike said to be 15 feet wide is being prospected for tin. A specimen shows a short narrow opening carrying black cassiterite and small crystals of quartz. The hope of paying deposits in the slates would seem to lie in finding stockworks (networks of small veins) rich enough to pay for working. These have been successfully worked in slate in Cornwall and the Malay Peninsula.

At many places veins and small replacement deposits of pyrite are found in the slates and these have been said to carry stannite (tin pyrites). Six samples collected at points where stannite was said to exist were submitted to E. C. Sullivan, of the United States Geological Survey chemical laboratory, but he was unable to find a trace of tin in them.

Ears Mountain.—Prospecting on Ears Mountain continued during the summer of 1905, probably a dozen men being there during different parts of the season. While cassiterite undoubtedly has been found on the mountain, it is nevertheless true that most of that brought out as such is something else. The mineral generally mistaken for cassiterite is tourmaline, and at Ears Mountain the two are remarkably similar, for often neither shows its crystal habit well and both are black and without cleavage, so that men who have seen the cassiterite-bearing rocks are ready to declare that tourmaline-bearing rocks of similar appearance are "exactly the same" as those which showed tin on assay. And it is almost impossible to differentiate them by eye alone.

Another mineral that has been repeatedly mistaken for cassiterite is augite, which occurs as peculiarly large black crystals, reaching 2 inches or over in length in granitic rocks of rather dark color. The augite is not so difficult to tell from cassiterite as tourmaline, having a much lower specific gravity and breaking along distinct parallel lines, which cassiterite will not do.

Cost of Mining.

At present wages in the York region are $5 and board, and good board can not be considered as worth less than $1.50 to $2.50 per day, making wages the equivalent of $6.50 to $7.50 per day. At Cripple Creek, Colo., where average wages may be considered as perhaps $3.75, in the Portland mine, [a] the cost of removing all rock, both barren and ore bearing, was $3.13 per ton. The rock here is only partly granite, a part being softer breccia and intrusive. At Butte, Mont., the cost of mining in granite has been about $3.50 per ton,[b]

[a] Finley, J. R. Ninth Ann. Rept. Portland Gold Mining Company, February 2, 1903, p. 13

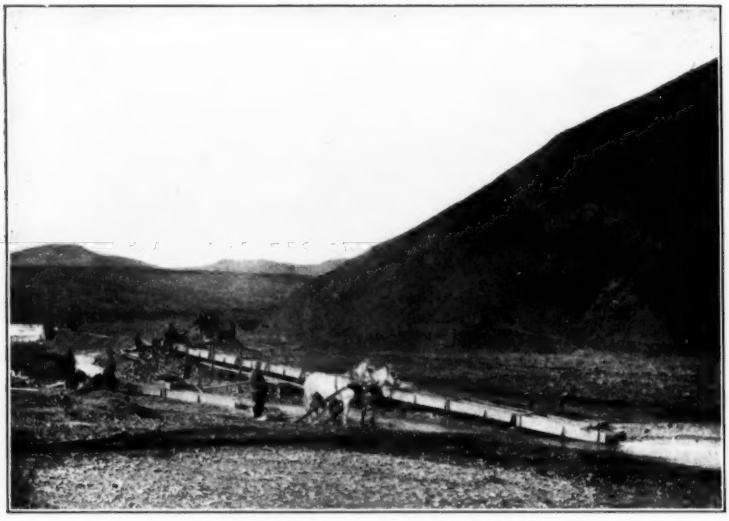
[b] Communicated by W. H. Weed.

ICE BLOCKS SHOVED UP ON THE ARCTIC SHORE ON THE NORTH SIDE OF CAPE PRINCE OF WALES.

with wages averaging about $3.50 per day. An average of these two examples gives about $3.32 per ton for the cost of raising ore, exclusive of milling and smelting charges. In view of the cost of wages, materials, machinery, etc., it is hardly possible to suppose that the cost of mining in the York region can be less than twice this amount, or about $6.64 per ton. In 1903 the price for which black tin (i. e., the cassiterite concentrated from the ore) sold from the Cornwall mines was 16.1 cents per pound, but no data are at hand as to its purity. In the assumption that it was about 70-per-cent pure, this would be about 23 cents per pound for the contained tin. At $6.64 per ton for ore raised and 50 cents for milling and concentrating, a total of $7.14, it would take a minimum average of about 31 pounds of tin per ton of rock mined, or 1.55 per cent, to pay for working. However, this estimate allows nothing for transportation, sinking fund, prospecting, legitimate profit, etc., and it seems safe to figure that under present conditions nothing less than 2½ per-cent ore can be worked with a reasonable assurance of profit.

Placer Deposits.

Buck Creek.—The placer tin deposits on Buck Creek are the only ones in Alaska from which there has been any production, and they have yielded to date about 91 tons of ore that would average probably 65 per cent of metallic tin. In this amount is included the pro-



SLUICING PLACER TIN ON BUCK CREEK.
The picture shows one of the rocky hills along the creek.

duction of 1905, which was very small, owing to bad weather and other reasons. During the year the trail between York and Buck Creek was changed somewhat. Instead of following Anikovik River to a point opposite the head of Grouse Creek, the trail now leaves the river at Ishut Creek, which is followed to its head, then crosses a narrow divide and traverses Gold Creek to Grouse Creek and that to the mouth of Buck Creek. By this change the bad divide between Grouse Creek and Anikovik River is avoided. The total haul is from 14 to 16 miles.

But one company operated on the creek during the season. Its plant consisted of an oil-burning 35-horse-power upright boiler and engine, French scraper with belt conveyor, and sluice boxes elevated 16 feet above the ground. Two sets of sluice boxes side-by-side are used, so that there need be no stoppage of work for clean-ups.

The work has shown the gravel to carry an average of from 20 to 30 pounds of concentrates, running from 60 to 70 per cent of metallic tin and about 40 cents in gold per cubic yard. The gravel is from 120 to 160 feet wide, averaging about 125 feet, by 3 to 6 feet in depth, averaging about 4½ feet. The tin-bearing gravels extend from the mouth to Peluk Creek, a tributary of Right Fork. Left Fork and Peluk Creek are said to carry stream tin also, but in the case of the

latter obtaining water for sluicing will be a serious difficulty. Sutter Creek has so far shown but little stream tin. There is probably a length of about 4 miles of tin-bearing gravels in the Buck Creek Valley. It has been reported that scheelite and monazite were found in these gravels in paying quantities, but I have been unable to find either. The specific gravity of scheelite (5.9-6.08) would make it practically impossible to wash it from the stream tin, whose specific gravity is 6.4 to 7.1 and is liable to be lower on account of impurities.

The great interest that these deposits have aroused is shown by the amount of "experting" that has been done. At least seven parties have been sent to Buck Creek by firms or private persons to examine and report on the tin gravels, and the expense has been probably much in excess of $50,000. Holes have been started where bed rock could not be reached except with a steam pump or a bed-rock drain, neither of which were had, and signs of crosscuts are almost wholly wanting, yet reports were probably made on the depth and value of these gravels. One published report states that it was "impossible to examine any of the rock in place except on the extreme summits," and yet the bare slate stands along the creek in a bluff 75 feet high, as shown opposite. During the present season operations are said to have been more successful than during 1905.

Grouse Creek.—Grouse Creek, into which Buck Creek flows, has so far shown little stream tin above the confluence, but below prospectors report from 3 to 40 pounds of stream tin per cubic yard of gravel through a breadth of 100 feet. Bed rock was not reached and the depth of gravel is unknown. It was said that the best prospects are on the western side of the valley, and that the tin varies in size from small crystals to lumps as large as one's fist.

Red Fox and Other Creeks.—The creeks flowing into Lopp Lagoon from the hills north of Buck Creek are all said to show good prospects of stream tin, but the extent of the tin-bearing gravels is as yet unknown and the question of water for sluicing will be a serious one.

Mint River.—Mint River, into which Grouse Creek flows, has been widely advertised as having tin-bearing gravels, but prospectors who worked on the stream during the last summer reported that they were unable to find any stream tin. Prospectors of former years, however, have reported its occurrence.

Ears Mountain.—Stream tin has been reported in several of the streams flowing from the northeast and east sides of Ears Mountain, but they have not been prospected enough to show their extent.

THE PLANNING AND CONSTRUCTION OF THE POWER PLANT.

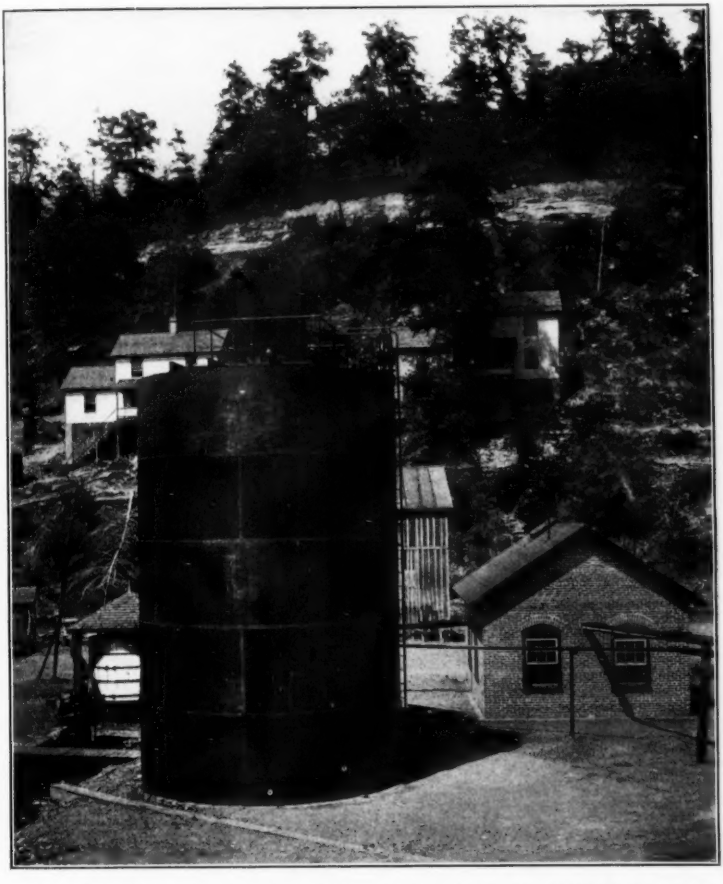
By A. E. Dixon.

IV. WATER SUPPLY AND ITS PURIFICATION.

Mr. Dixon's series began in August, and preceding installments have discussed the location of the plant; the storage of fuel; boilers, grates and chimneys; and natural and mechanical draft The January section will take up prime movers.—THE EDITORS

IN the determination of a site for a steam-driven power plant the question of the water supply should be very carefully investigated; not only the quantity available, but the quality of the water is of the highest importance. Where it is possible the supply should be drawn from two independent sources, each of which should be ample to cover the maximum requirements of the plant. In some cases artesian wells are used for this purpose, even in localities where a public water supply is available, while in other cases the plant draws its entire requirement from the public supply; again, the public supply is depended upon for the boiler feed water and the circulating water for the condensers is drawn from other sources. With small plants the question of water supply is comparatively easy to settle; but with large plants the question is more involved, and in many cases it is necessary to provide against interruptions in the supply, by the use of storage tanks. This is particularly the case when the supply of boiler feed water is drawn from the city mains, it being customary in such cases to provide sufficient tankage to hold from 12 to 24 hours supply.

The modern plant is operated condensing, and while the water for this purpose need not be suitable for the boilers, the supply must be of ample volume, as from 25 to 90 pounds of water must be passed through the condensers for every pound of steam condensed, the larger quantity being required by turbine plants operating with a high vacuum. The amount of this circulating water is governed by the maximum initial temperature of the source of supply, as well as by the vacuum maintained, as it is necessary to cover the most unfavorable conditions. The amount of steam required per horsepower hour for the several types of prime movers varies greatly, ranging from 10 to 40 pounds, according to the pressure and the amount of superheat employed and whether operated condensing or non-condensing; while the plant auxiliaries, together with the

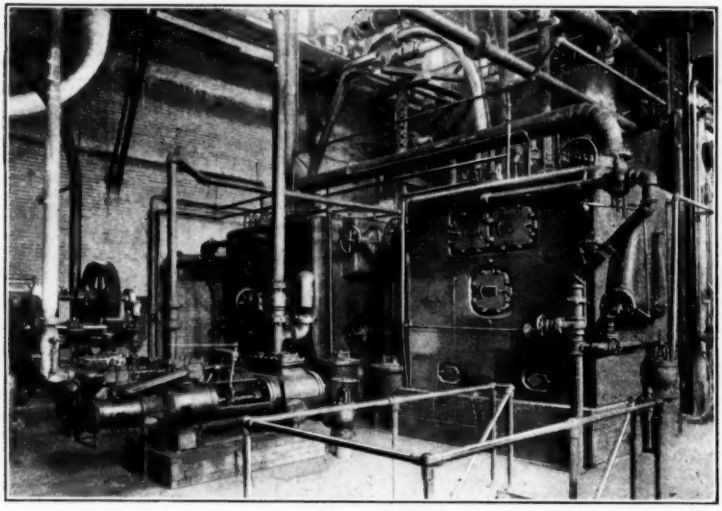


WATER-PURIFICATION PLANT, ELKHORN COAL & COKE CO., MAYBEURY, W. VA.
Treating capacity 10,000 gals. per hour; for domestic, as well as boiler purposes.
L. M. Booth Co., N. Y.

house service and heating requirements, will consume from 5 to 12½ per cent of the amount of steam required for the main units, depending upon the season of the year. The amount of auxiliary steam can be greatly reduced by the use of electric motors in place of steam engines; but while such an arrangement may have some advantages in the line of reducing the amount of steam and exhaust piping, as well as in economy of labor, it renders such machinery dependent upon the main units and subject to any electrical accident which affects the switchboard. Such auxiliaries have not been

looked on with favor for the most recent plants, for the reason that a high degree of economy is reached by steam-driven auxiliaries when the exhaust steam can be utilized in heating the feed water.

With properly designed oil separators it is possible to return the greater portion of the exhaust steam to the boilers, the supply of



DOUBLE-UNIT SORGE-COCHRANE SYSTEM OF WATER PURIFICATION, LOUISVILLE RAILWAY CO.

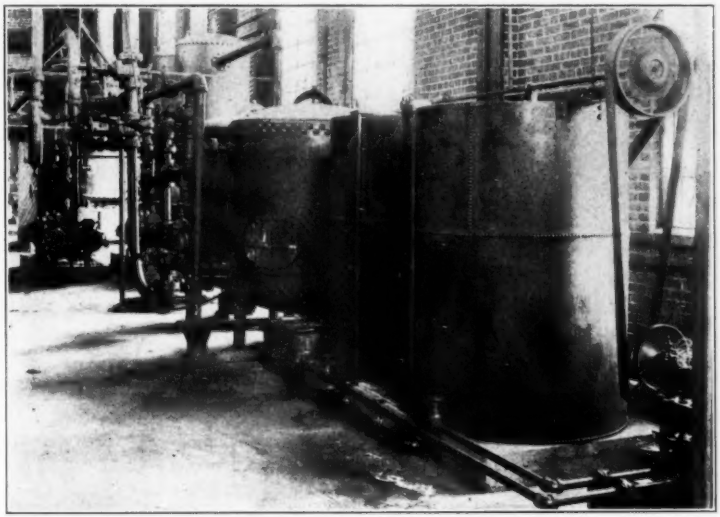
The plant is of 5,000 horse-power. Harrison Safety Boiler Works.

make-up water in this case being that required to supply the loss due to leaks, to the blowing off of boilers, and to the steam used in dusting tubes, etc. In plants using salt circulating water with surface condensers, a small percentage of salt water will reach the boilers owing to the fact that it is impossible to prevent the occurrence of slight leaks in the condensers, and it is necessary, therefore, to guard against undue concentration of the salt in the boilers. In some prominent plants barometric condensers are used with salt injection, thus wasting the condensed steam, the reason for this being a desire to avoid all danger of contaminating the boiler feed with oil from the engines. Where the water supply is drawn from city mains this method of operating leads to a large water bill; a private source of supply will be cheaper for such cases when it is possible to develop it by an investment whose fixed charges are from 30 to 50 per cent of the annual water bill. In New York city the charge for water is 10 cents for 100 cubic feet, and the water bill of some of the

large power plants is approximately 10 per cent of their coal bill; it will be evident that considerable saving can be made in this item.

Artesian wells are occasionally put down by power plants. The advisability of such a step depends greatly upon the locality, and occasionally the water reached will be highly mineralized and of such a character that it cannot be utilized and will not yield to chemical treatment.

At interior points a site on a lake or river is desirable; in the latter case a stream should be selected, if possible, whose minimum rate of flow somewhat exceeds the maximum requirements of the plant. In dealing with riverside sites it is necessary to go very carefully into the question of flood and low-water levels, in order to avoid plant shut-downs from high or low water; floods may drown the plant out, while low water may uncover the pump suctions. In



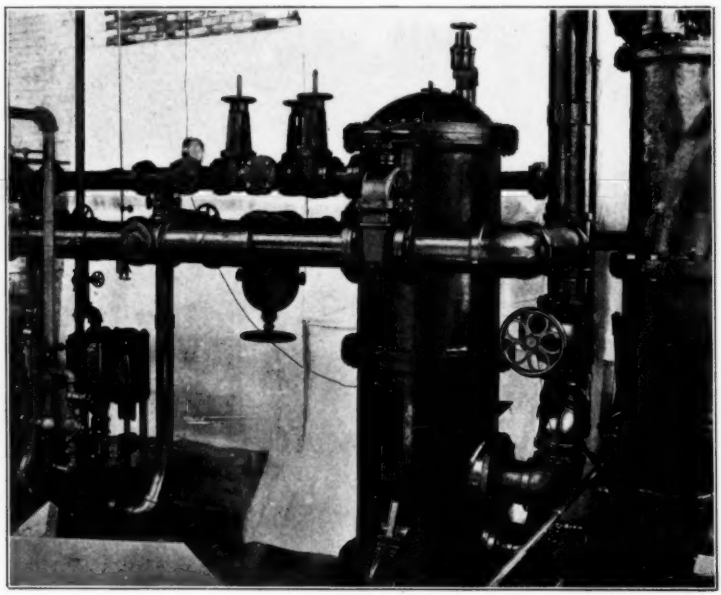
SCAIFE WATER-SOFTENING AND PURIFYING SYSTEM, PITTSBURG TERMINAL WAREHOUSE & TRANSFER CO.

A 2,000-horse-power equipment. Wm. B. Scaife & Sons Co., Pittsburg, Pa.

some cases it has been found desirable to construct a regular water-works intake at a point where a suitable depth of water could be obtained at all times, supplied with suitable means of controlling the flow at both high and low water. In localities where the country rock is sandstone or granite the water in the streams will usually be soft, while in limestone regions hard water will be found. In the

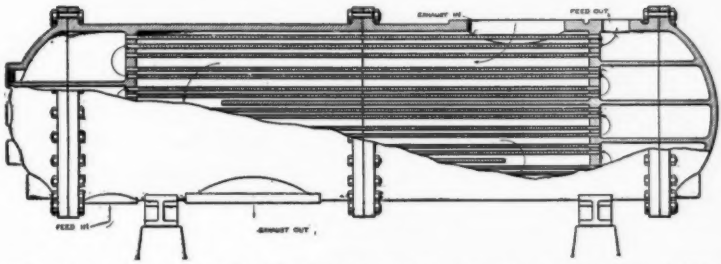
vicinity of mines or chemical works the rivers, whether fresh or salt, are liable to contain acid refuse which will cause considerable trouble; the organic matter from the sewage of towns is also troublesome to deal with if present in quantity. At times of flood, river water, even that which is normally hard, becomes very soft owing to the large quantity of rain water or melted snow; but at the same time the water carries a large quantity of mud in suspension, sometimes as much as 4 or 5 per cent by volume, and rapidly flowing streams always carry some matter in suspension. Such water is hard on pumps. In many power plants a crude home-made filter is the only apparatus used for clarifying the water, and the expense caused by frequent boiler cleanings and the repairs due to the bad water used are looked upon as necessary but unavoidable evils.

All water, as found in nature, contains some impurities in solution or suspension, and while the amount may be small per gallon it assumes great importance where large quantities are evaporated.



WAINWRIGHT 2,000-HORSE-POWER WATER-TUBE EVENFLOW HEATER IN A NEW ENGLAND FACTORY.

Embodying the features of counter current, multi-pass, and corrugated tubes. The water, entering by the 5-in. opening at the bottom, passes seven times through the shell, by seven groups of corrugated copper tubes. The exhaust steam enters at the top, just under the feed-water exit, and passes through three times.
Alberger Condenser Co., N. Y



SECTIONAL VIEW OF WAINWRIGHT EVENFLOW WATER-TUBE HEATER, HORIZONTAL TYPE.

Alberger Condenser Co., New York.

For instance, a boiler evaporating 1,000 tons of water per month will accumulate 225 pounds of solid matter if fed with the comparatively pure Croton water, used in New York City; while in less favored localities the quantity of solid matter may run over 6,000 pounds from the same quantity of water. It is impossible to classify waters as "good" and "bad" on hard and fast lines, for the reason that the different classes shade into each other; besides, what would be looked upon as a very poor water in one locality would be considered a good water in another. Prof. L. M. Norton in a lecture upon "Industrial Chemistry" presented a very complete tabulation of the causes of trouble with water used for steam making and the remedies or palliatives to be employed, as follows:—

Troublesome Substance.	Trouble.	Remedy or Palliative.
Sediment, mud, clay, etc.	Incrustation.	Filtration. Blowing off.
Readily soluble salts.	Incrustation.	Blowing off.
Bicarbonates of lime, magnesia, iron.	Incrustation.	Heating feed water. Addition of caustic soda, lime, or magnesia.
Sulphate of lime	Incrustation.	Addition of carbonate of soda, barium chloride.
Chloride and sulphate of magnesia.	Corrosion.	Addition of carbonate of soda, etc.
Acid (in mine water).	Corrosion.	Alkali.
Dissolved carbonic acid and oxygen.	Corrosion.	Heating feed water. Addition of caustic soda slacked lime, etc.
Grease (from condensed water)	orrosion.	Slacked lime and filtering Carbonate of soda. Substitute mineral oil
Organic matter.	Corrosion.	Precipitate with alum or ferric chloride and filter.
Organic matter (sewage).	Priming.	As above.
Carbonate of soda in large amounts and carbonates of lime and magnesia.	Priming.	Addition of barium chloride, etc.

The mineral matters causing the most trouble are the bicarbonates and sulphates of lime and magnesia, oxides of iron, alumina, and silica. While some of these substances are less soluble in hot water than in cold, and are insoluble at high temperatures, it takes some time for them to crystallize out of the water; for this reason, while it is possible to remove a portion of these impurities in an exhaust-steam heater, it is impossible to remove them entirely even by the use of a live-steam heater. The process of water purification cannot be hurried.

SCALED PANS FROM 3,000-HORSE-POWER HOPPES FEED-WATER HEATER, PEOPLE'S LIGHT, HEAT & POWER CO., SPRINGFIELD, OHIO.

62½ cu. ft. of lime and magnesia removed from pans at one cleaning, after 30-days run.

Boiler compounds have a certain degree of value when they are prepared to suit the special case; otherwise they may have an effect directly the opposite of that desired; in addition, being proprietary articles they are in most cases expensive and often consist of soda-ash or lime colored to disguise their nature so they can be sold at a fancy price. The boiler compound at its best merely changes the character of the deposit in the boiler to a mud that can be blown out; at the same time the amount of the deposit is increased. This mud must be removed from the boiler by blowing out more or less of

the hot water along with the deposit; and while scale is very undesirable in a boiler, so likewise is any other deposit.

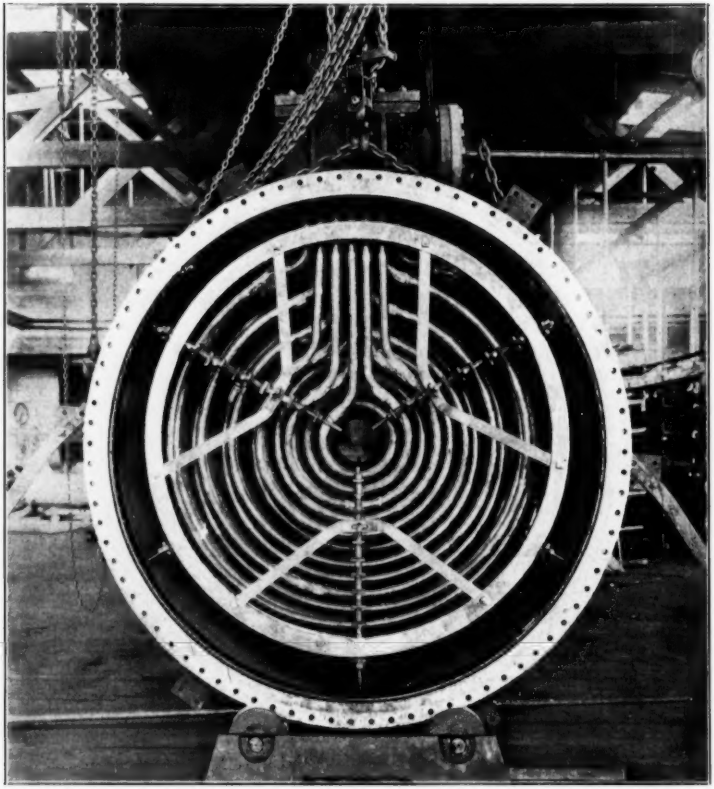
The rational method of handling the scale problem is to eliminate the scale-forming substances as far as possible before the water reaches the boilers. There are two methods of treating the water, the continuous and the intermittent process. In the continuous process the dissolved reagents are fed into the flowing stream or into a precipitating tank, the endeavor being to obtain an even mixture; this is difficult, as the solution may vary in strength, and the rate of flow of the water may vary, the solution valves may clog, etc. This process, however, has met with considerable success and in some apparatus the use of valves for the solutions is avoided. The continuous process requires less ground area than the intermittent process, as the use of settling tanks is avoided. The intermittent process is probably the most satisfactory method to employ provided sufficient ground area is available for the large settling tanks required. These tanks must be of sufficient size to insure ample time for the chemical reaction to occur; in addition, the sludge which is stirred up through the water being treated assists in clarifying it. These tanks, with the treated-water well, act to an extent as reserve water supply.

The chemical process of purification is assisted by heat, and exhaust steam is sometimes used to heat the raw water prior to the addition of the reagents; this method is common in continuous purifiers installed in boiler plants, but has also been used with the intermittent process.

The filter is an essential element of any water-purifying plant, owing to the fact that it is impracticable to supply sufficient tank capacity to permit of the water clarifying itself by settlement.

The operation of any water-softening plant should be checked up from time to time by the chemical analysis of both the raw and treated water. A test should be made several times a day by the plant operator, and several times a week his tests should be checked by an inspector, using duplicate samples taken by the operator at the same time his own samples were taken. The tests are simple and can be made by any operator who can accurately follow printed and verbal instructions; they involve no knowledge of chemistry, and with a little practice it will be found that the operator will agree very closely with the laboratory.

It is not practicable to purify the water completely by the use of chemicals, but it is possible to reduce the amount of scale-forming substances to such an extent that the amount of boiler cleaning re-



INTERIOR OF 8,000-HORSE-POWER NATIONAL FEED-WATER HEATER FOR COS COB POWER PLANT, N. Y., N. H. & H. R. R.

Vertical type, 11 ft. 2 in. high by 7 ft. diameter. 42 coils of copper tube 1⅝ in. outside diameter National Pipe Bending Co., New Haven, Conn.

quired will be greatly reduced, and in some cases the result has been so nearly perfect that the boilers have been run for months with an occasional washing out only.

The evil effects of cold boiler-feed water have often been dealt upon, not only with regard to the resulting increase in the coal bill but also with regard to the injurious effect of the cold water upon the boiler shell. The boiler is installed for the purpose of generating steam, and to obtain the highest efficiency from the steam-generating surface the feed water should reach the boiler at or but slightly below the temperature of saturated steam at the operating pressure of the plant; the use of cooler feed water means an increase in the amount of boiler-heating surface and a considerable drop in the efficiency

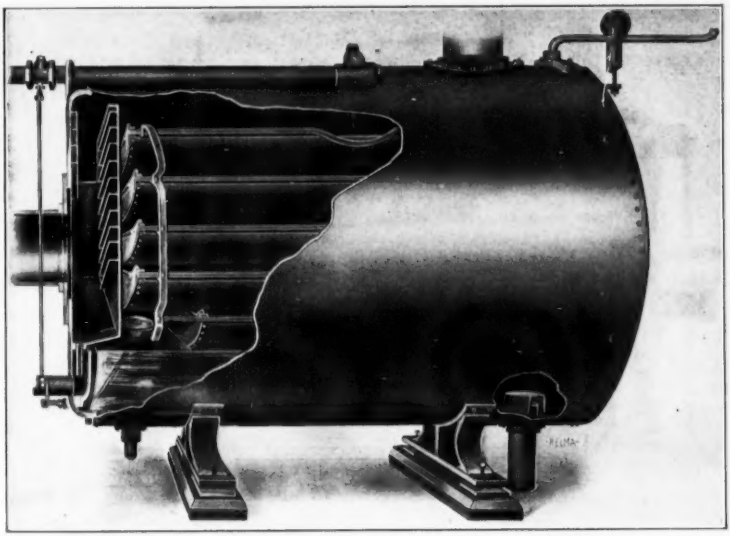
of such surface. A number of tables have been published to show the gain made by heating the feed water; these tables are based upon the following formula:—

$$x = \frac{h'' - h'}{H - h'}$$

in which

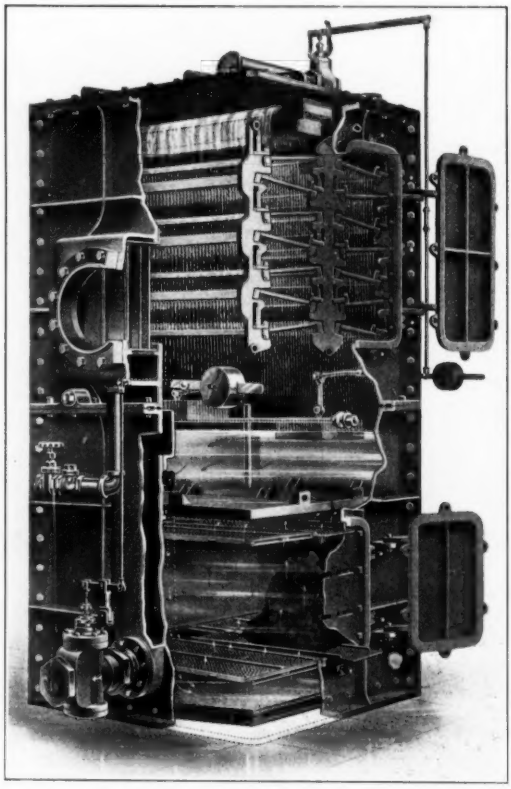
x = Percentage of gain by heating feed water.
H = Total heat in 1 pound of steam at boiler pressure.
h' = Initial heat in 1 pound of feed water.
h'' = Final heat in 1 pound of feed water.

There are two types of exhaust-steam feed-water heaters—the open and the closed. Live-steam heaters are not often used and are of the closed type. The open heater is a box-shaped or cylindrical receptacle of steel or cast iron into which the exhaust steam is admitted through an oil separator; the heater is usually provided with a vent with a free exhaust or back-pressure valve so that there will be no accumulation of pressure in the heater. The entry of cold water takes place at the top of the heater and is controlled by a ball float valve; the water flows over a series of trays or baffles, so ar-



HOPPES STANDARD FEED-WATER HEATER WITH SKIMMER OVERFLOW AND OIL-CATCHER DRAIN.

Hoppes Manufacturing Co., Springfield, Ohio.



SECTIONAL VIEW, WEBSTER FEED-WATER HEATER AND PURIFIER.

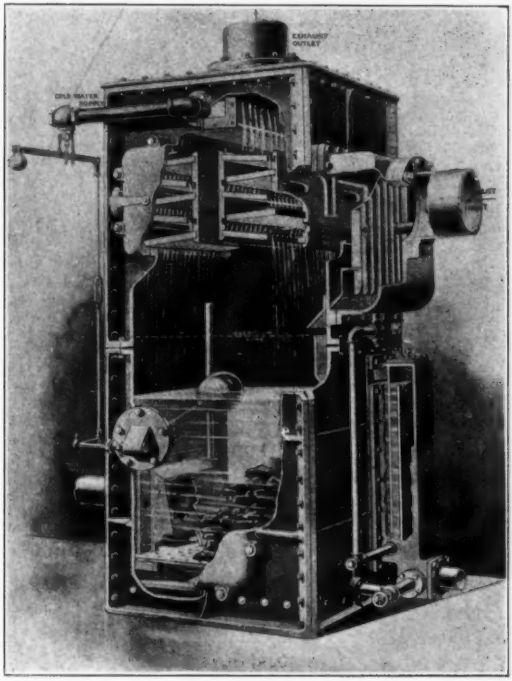
Made in sizes from 1,000 to 2,500 horse power, in this type. Warren Webster & Co., Camden, N. J.

ranged as to expose a large surface to the steam, down to a hot-water well in the lower part of the heater, from which the water should flow to the feed pump by gravity. In some heaters the water flows through a filter before reaching the pump suction. The hot drips from the various piping systems and machines can be advantageously led to heaters of this kind, but care should be used to see that all drips liable to contain oil are passed through an oil separator before reaching the heater.

Closed heaters are usually of the water-tube type, very rarely of the steam-tube type; they consist of a closed receptacle, usually cylindrical, within which the tubes are arranged either in coils or extending from one head to the other. In one make of heater corrugated tubes are used, it being claimed that they cause less trouble from expansion and are more efficient transmitters of the heat. These heaters are usually supplied with a steam inlet and outlet, the latter being occasionally supplied with a back-pressure valve; in some cases the vent is omitted, reliance being placed upon the vacuum resulting from the condensation of the steam to keep up the supply, but as the steam is liable to contain more or less air, unless proper

provision is made, a heater installed on this sytsem is liable to become air bound. As the interior of the steam chamber is at or slightly below atmospheric pressure the piping and trap for draining off the water of condensation must be arranged accordingly. To insure the best results the velocity of the water in the tubes should be from 400 to 800 feet per minute. Closed heaters are generally arranged between the feed pumps and the boilers, so that the water in them is under pressure, and they should be subjected to a pressure test.

The efficiency of a closed feed water heater, under test conditions, with a minimum difference in temperature between the inflowing steam and the outflowing water of 32° F., may run as high as 95 per cent; but under actual operating conditions an efficiency of from 80 to 85 per cent is about what is realized. The closed heater is handicapped by the fact that the heat has to be transmitted through the walls of a tube or a plate, and in addition the water of condensation is wasted; as this type of heater is not provided with an oil separator the tubes become coated and the heater must be cleaned out from time to time of this deposit; a steam hose is of use for this purpose. The open heater, owing to the fact that the steam comes into direct contact with and is condensed and included in the feed water, has an inherent efficiency higher than the closed heater, the only losses being the small amount of drip from the oil separator and from radiation. When the oil separator is well designed it is



INTERIOR OF COCHRANE VERTICAL FEED-WATER HEATER.
Harrison Safety Boiler Works, Phila., Pa.

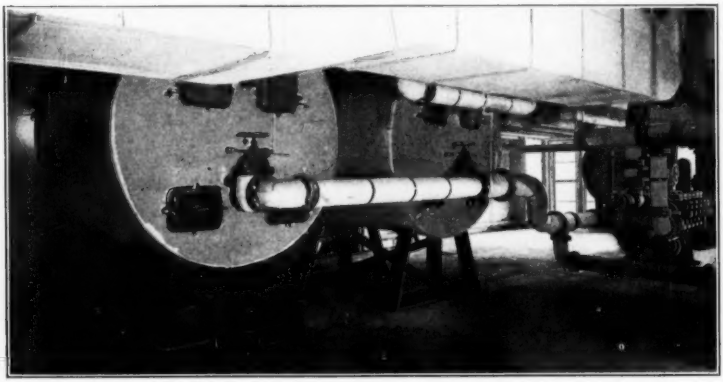
found that there is no difficulty whatever in using this condensed steam in the boilers.

The rise in temperature and the final temperature due to the use of a closed feed-water heater can be computed by the following formulas:

$$t = \frac{w\ H\ K}{W} \qquad t'' = t' + t$$

in which

- t' = Initial temperature of water, degrees F.
- t'' = Final temperature of water, degrees F.
- t = Rise in temperature, degrees F.
- w = Weight of steam reaching heater in pounds.
- H = Latent heat in steam.
- W = Weight of water passing through heater, in pounds.
- K = Per cent efficiency of heater.



TWO WEBSTER FEED-WATER HEATERS AND PURIFIERS, POWER PLANT OF THE WANAMAKER BUILDING, PHILA.

The interior construction is essentially like that of the heater shown on page 380, but the form is cylindrical instead of rectangular. Warren Webster & Co., Camden, N. J.

The above formula is based upon the assumption that the steam reaching the heater is condensed to water.

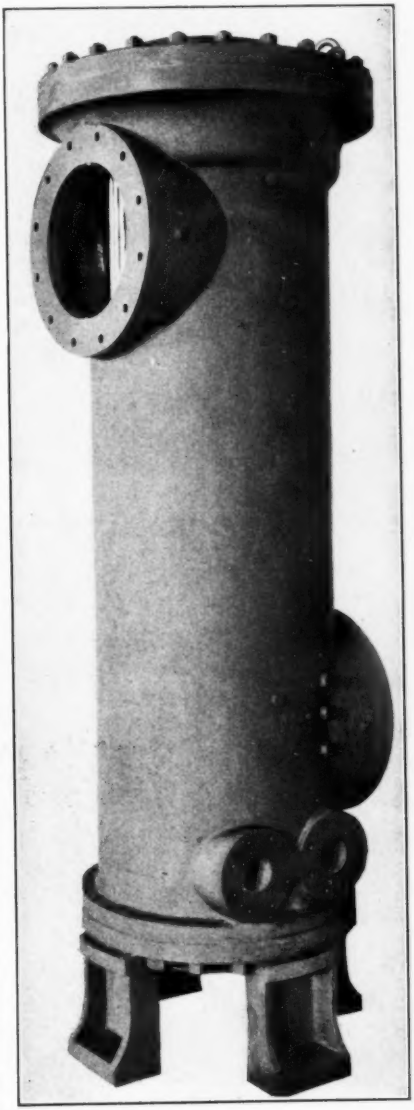
The final temperature due to the use of an open heater can be calculated by the formula:

$$t'' = \frac{W\ (t' - 32) + w\ H}{W + w}$$

in which the letters have the same meaning as in the preceding formula.

From the final temperature as arrived at by the formulas a deduction must be made to cover the loss due to radiation, as this loss exists even when the heaters and piping are well covered with a first-class insulator; the temperature of the feed water will drop from 3 to 10 degrees between the heater and the boiler, depending upon the conditions peculiar to the individual plant.

The chimney losses in the average power plant will run over 20 per cent; one of the means available for the reduction of this loss is the use of flue feed-water heaters, or economizers; these consist of a battery of cast-iron pipes set in rows in top and bottom headers, the joints exposed to the heat being made metal to metal. The vertical pipes may be arranged to give a straight passage for the flue gases, or may be staggered in order to break up the currents of hot gases; these pipes are usually set 8 inches center to center, but wider spacing can be used to increase the free flue area; or additional area may be obtained by the use of side passages with dampers on one or both sides of the tubes. In order to pre-



BLAKE VERTICAL-MULTI-CURRENT FEED WATER HEATER. 800 HORSE-POWER. International Steam Pump Co., N. Y.

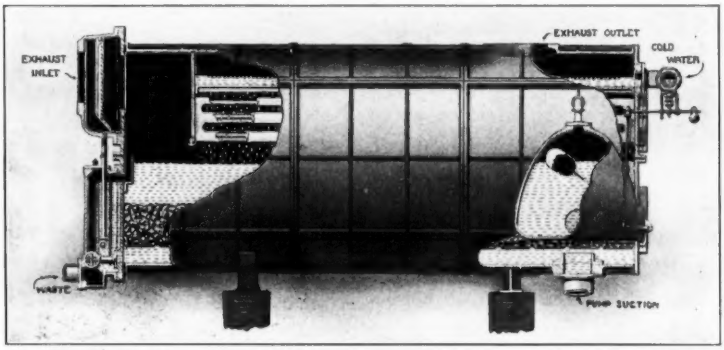
vent the accumulation of soot on the tubes, which greatly reduces the efficiency of the heating surface, scrapers are provided which may be driven by the stoker engines, or a suitable motor may be installed for this purpose. The amount of economizer heating surface provided varies from 25 to 50 per cent of the boiler heating surface.

The rise in temperature due to passing the feed water through an economizer can be computed by the following formula:

$$x = \frac{y\,(T' - t')}{8.57 + \left(\frac{159 + GF}{2GF}\right) y}$$

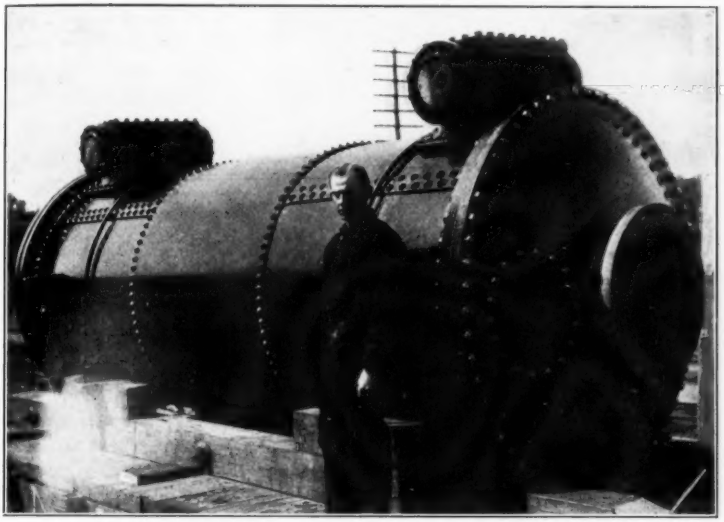
in which

x = Rise in temperature of feed water, degrees F.
T′ = Initial temperature of the flue gases, degrees F.
t′ = Initial temperature of the feed water, degrees F.
G = Pounds of flue gas per pound of coal.
F = Pounds of coal required to evaporate 30 pounds of water per hour.
y = Square feet of economizer heating surface provided for 30 pounds of water per hour passed through the economizer.



COCHRANE HORIZONTAL CYLINDRICAL FEED-WATER HEATER AND PURIFIER.
Harrison Safety Boiler Works, Phila., Pa.

This formula is based upon the following assumptions: that the specific heat of the flue gases is the same as that of air; that 3.5 British heat units will be absorbed per square foot of heating surface per hour for each degree of difference between the mean temperature of the flue gases and the feed water; and that 80 per cent of the heat lost by the flue gases is absorbed by the feed water.

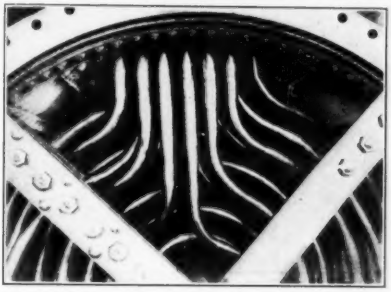


ONE OF THE 6,000-HORSE-POWER FEED-WATER HEATERS FOR KINGSBRIDGE POWER HOUSE, THIRD AVE. R. R., N. Y.

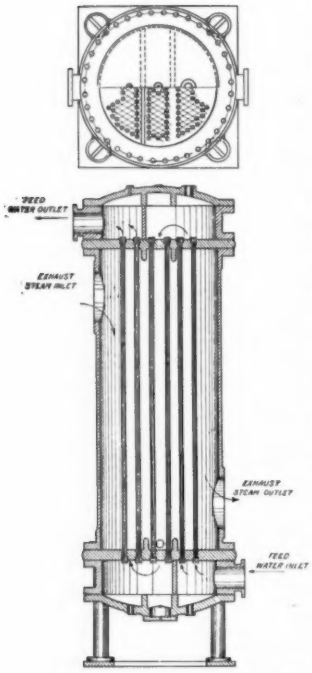
Whitlock Coil Pipe Co., Hartford, Conn.

The efficiency of the heating surface of an economizer will vary greatly, particularly if the coal used and the methods of firing tend to develop smoke, in which case a heavy deposit of soot will occur in the economizer; for this reason, in order to secure the best results from an economizer, it is advisable to keep the scrapers going all the time the plant is in operation.

There are two methods of operating an economizer; in the method most used the water is fed in at the lower header and the vertical tubes are all in parallel as regards circulation; this arrangement makes a very slow current ascending the tubes at the chimney or cool end of the economizer, while at the end where the hot gases enter the circulation is more rapid. In the other method of operation the water is fed in at the chimney end of the economizer and circulates through the vertical tubes in series to



INTERNAL VIEW, WHITLOCK COIL PIPE HEATER.



WHEELER CONDENSER AND ENGINEERING CO'S FEED-WATER HEATER.

the end where the hot gases enter. A blow-off connection is necessary, as owing to the high temperatures reached in the economizer some of the impurities in the feed water are thrown down; and in order to guard against any trouble from the generation of steam in the economizer, or to prevent sudden rises in pressure, a safety valve must be placed on the upper header.

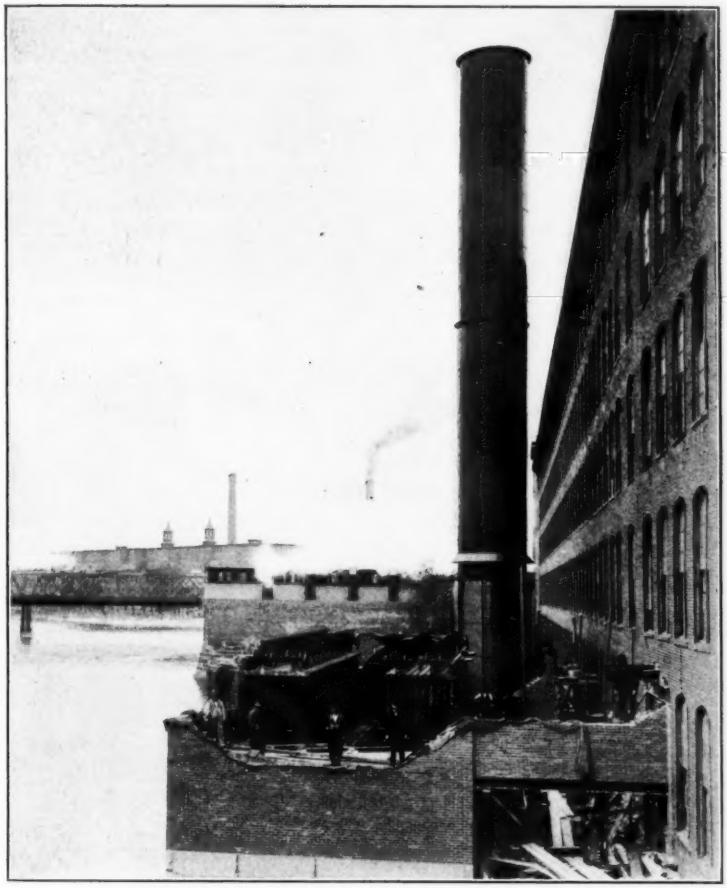
The economizer has been omitted in some of the recent plants, dependence being placed on the feed-water heaters using the exhaust from the auxiliary machinery; while in other cases provision has been made for the installation of economizers should the operation of the plant show that they were desirable. The 59th Street plant of the Interborough Rapid Transit Company in New York City was operated for some time without economizers, a contract being let for this apparatus when it developed that such an installation would pay.

One of the obvious advantages of the economizer arises from the fact that each tube contains a reserve supply of 62 pounds of hot water, making, with the usual proportion of economizer to boiler heating surface, a reserve equivalent to about one hour's steam consumption ready for immediate use at times of emergency. In heavy traction service a reserve of this kind is particularly valuable for the reason that the afternoon peak comes on as a sudden swing and not as a gradual increase.

In order to reduce the amount of excavation required, the condensing water mains are often run with the outfall on top of the intake, thus making a slight saving in the first cost; a preferable arrangement places the two mains side by side, the condenser outfalls being carried down by cast-iron pipes to the same level as the suction pipes for the circulating pumps; this insures equal submergence of both pipes at all stages of water and results in a syphon action being set up through the condenser which reduces the power required to the amount necessary to overcome friction and the entry head. The saving resulting from the first mentioned method of construction is

limited to the excavation in the building, as upon these mains leaving the building it is necessary to separate them in order that the warm water from the outfall shall not be drawn into the intake.

The intake should be provided with a rack for keeping out drift wood and other débris, and a platform should be provided above the rack in order that it may be raked clean from time to time; in cold



ECONOMIZER INSTALLATION UNDER CONSTRUCTION, WASHINGTON MILLS, AMERICAN WOOLEN CO., LAWRENCE, MASS.

Green Fuel Economizer Co., Matteawan, N. Y.

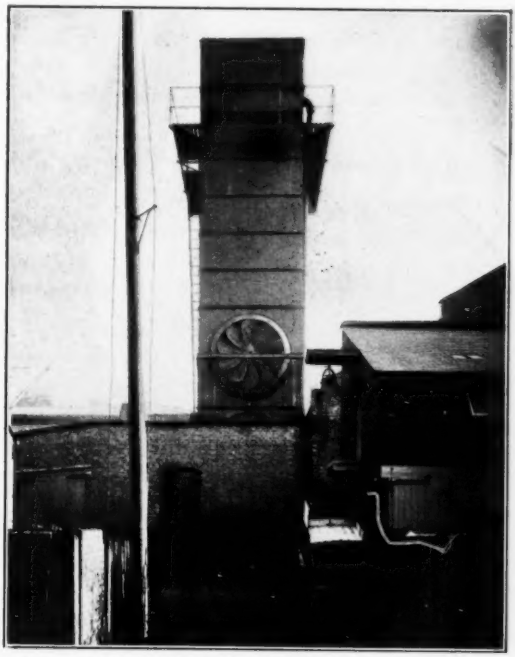
ARRANGEMENT OF GEARING ON TOP OF ECONOMIZERS, ARLINGTON MILLS, LAWRENCE, MASS.

B. F. Sturtevant Co., Hyde Park, Mass.

ECONOMIZERS FOR 6,000-HORSE-POWER INSTALLATION, SPRECKELS BEET SUGAR REFINERY, SALINAS, CAL.

The installation is shown ready for bricking in. Green Fuel Economizer Co., Matteawan, N. Y

climates it is necessary to break the ice from this rack, and in streams abounding in "frazil" or anchor ice, it may be necessary to provide special means, according to the location, for handling the trouble. In back of the rack should be located chases for a shut-off gate; this gate should be provided with a small valve operated by hand, for equalizing the pressure on both sides of the shut-off gate as it cannot be lifted while exposed to water pressure. A double sectional screen with a fine mesh should also be provided, so arranged that the various sections can be raised and cleaned without interrupting the operation of the plant. These screens are generally built with white-oak frames bound with iron straps; the screen consists of copper or iron wires woven or strung from side to side, the mesh varying from ⅜ to 1 inch square, No. 10 B. W. G. being a size often used for this purpose. In proportioning, the free area of racks and screens should exceed that of the conduit by from 35 to 70 per cent, depending somewhat upon the local conditions. The area of the conduit should be sufficient to supply the maximum demand with a velocity of flow not over 5 feet per second in the intake; a velocity 25 per cent higher can be allowed in the outfall.



COOLING TOWER ERECTED FOR THE BROMLEY ELECTRIC CO., KENT, ENGLAND.

Capacity 20,000 lb. per hour. Wheeler Condenser & Engineering Co., N. Y.

It is desirable to locate both the suction pipes for the pumps and the outfall pipes from the condensers in pockets at the side of the conduit so that they will not be exposed to the direct

current; this will cut down the amount of vibration in these pipes and the joints will remain tight. In many cases the suction pipes are provided with foot valves, in which case the wells must be so large and the piping so arranged that these valves can be raised for cleaning and repairs from time to time. The foot valves are used to prime the circulating pumps by filling the suctions with water; these pumps can be primed without a foot valve by running a connection to the condenser with a float valve shut off which acts as soon as water reaches it; by this method the dry vacuum pumps, by creating a vacuum in the circulating pump, prime it.

In localities where the natural supply of water is not sufficient for condensing purposes it is possible to overcome the drawback by the installation of cooling towers; these may be of either of two types—natural draft or forced draft; in the former the tower is made of sufficient height to contain the cooling racks and is extended higher, forming a sort of chimney; the descending current of water heats the air in the tower and thus establishes a draft. The fan or forced-draft tower, owing to the better air circulation, is more efficient than the natural-draft tower. The sheathing of these towers may be either of wood or steel, and they are filled with a series of racks of wood, or in some cases small tile pipes, built in such a way as to break up the streams of water and expose the greatest amount of surface to the air currents. The water is distributed over the tops of these racks, which are usually at an elevation of from 30 to 50 feet; below the racks is an air chamber from 8 to 16 feet in height into which the fans discharge; below this chamber is the sump into which the water drains and from which it is pumped to the condensers. Occasionally a shallow pond is used for cooling by surface evaporation, or the warm water from the condensers is sprayed from nozzles; the cooling tower, however, is more efficient and occupies the least space. In some cases, owing to lack of ground space, cooling towers are installed upon the roof; when this method is employed the water circulates through the condensers by gravity and is pumped up from the sump or hot well to the top of the cooling tower.

The above methods of cooling can be used with either surface or jet condensers, and the boiler-feed water is usually drawn from the warm water leaving the condensers. The amount of power required to operate a cooling tower will vary with the amount of vacuum carried in the condensers, as this factor governs the amount of circulating water and the fan capacity required. The evaporation loss will be about 10 per cent less than the amount of boiler-feed water.

THE WATER POWERS OF PERU. THEIR DEVELOPMENT AND POSSIBLE APPLICATIONS.

By Emile Guarini.

The purpose of this article is to describe the amounts and relative locations of the water-powers of Southern Peru, the feasibility of their development, the present and prospective demand for power in the locality, and the possible application of electricity to old and new industries, the Tambo Valley and Lake Titicaca being the sources of supply, and the towns of Mollendo and Arequipa the markets for consumption, of the power produced. Interest in the future relations of the United States with the west coast of South America has grown largely, since the significant articles on the subject by Mr. Collins which we published in February, 1904, and the recent visit of Secretary Root to that region gives the further study of the region special timeliness.—THE EDITORS.

THE present developments of the southern Peruvian water-power are insignificant, being limited to a 1,000-horse-power installation furnishing light and power to Arequipa, and a very modest private lighting plant in the Tambo Valley.

At Mollendo there is today no power plant of any description. The Peruvian Corporation is about to install a steam plant to furnish power for industrial purposes and harbor work during the day, and for public lighting at night. The high cost of fuel and the uninterrupted demand for power during the 24 hours, however, make the advantages of a water-power installation apparent.

In the immediate vicinity of Mollendo, in the Tambo Valley, there are a number of small streams capable of developing several hundred horse-power, which can be easily utilized and transmitted electrically. The supply of power available from this source is so much greater than any demand in sight for it at Mollendo, that a primitive wooden water-wheel of local manufacture, in connection with a dynamo and a few kilometres of copper wire, would amply suffice for present requirements, and would represent a great saving in first cost and in operating expense over the proposed steam plant. The utilization of the city's water supply to operate a wheel before entering the distributing mains suggests an alternative source of power.

Mollendo gets its water from the mountains at an elevation of 2,300 metres above sea level, whence it is conveyed a distance of 140 kilometres through pipes, 20 centimetres in diameter at a velocity of 20 litres per second, according to chief engineer Bustamante y Raneda, in his recent report and project for increasing the

water supply of Mollendo. Friction losses would average 5 millimetres per metre of pipe, or 700 metres for the entire distance, not including loss of head from short turns, bends and angles.

On the basis of 1 horse-power = 175 kilogramme metres, net available, and allowing 75 per cent as the efficiency of the wheel, the theoretical available power would be 320 horse.

In practice, however, this result could not be obtained for two reasons: first, because the present pipe line could not resist the attendant pressure of 219 atmospheres, and second, because the entire theoretical head is not available owing to the fact that the line is sectioned off in several separate reservoirs at different levels, serving to supply intermediate towns and villages, and also to relieve the pressure on the line.

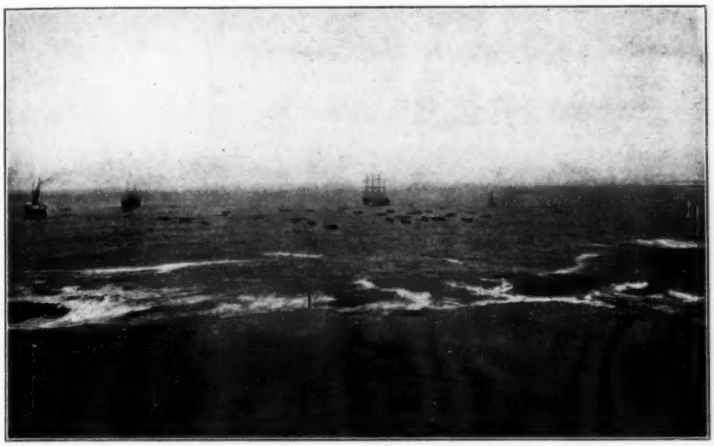
The power problem would consequently have to be solved by either of the following methods: 1.—By installing a water-wheel and alternating-generator set at the mouth of each reservoir, feeding a single cable carrying the current to Mollendo and furnishing power to different localities on the way. Under existing conditions, at least 250 horse-power could be delivered in this manner at Mollendo, during 24 hours, supplying 3,000 standard 16-candle-power lamps = 48,000 candle power, or 3,000 special-filament 32-candle-power lamps = 96,000 candle power.

This output could be further increased by installing a storage battery at Mollendo, which could be charged during the daytime.

2.—By building two reservoirs at Mollendo, at different levels; the lower one to be used as the supply reservoir proper for distribution, and the other as a water-power storage basin, which would empty into the lower reservoir during lighting hours.

Under present conditions, each reservoir would have a capacity of 900 cubic metres (that being the capacity of the existing basin), and a difference of mean level of 220 metres (that being the actual difference between the Mollendo reservoir and the last section basin). This would give a flow of 10 litres per second for 24 hours, or 40 litres per second for 6 hours, or an equivalent of 88 actual horse power, sufficient to supply 1,000 special 32-candle-power incandescent lamps for six hours, which would be fully adequate for the immediate needs of the little town of Mollendo.

The Tambo Valley abounds in small water-powers, which could be easily developed to supply power to run the machinery in the sugar mills that dot the valley, during the day, and to light the many estates and farms, at night.



THE ROADSTEAD OF MOLLENDO. A LARGE HYDRO-ELECTRIC POWER STATION IS TO BE INSTALLED AT THE PORT.

Today, the only application of these natural forces is to be found on Mr. Lira's plantation, where a miniature electric-lighting plant is run by a very primitive and inadequate water wheel of native design.

At Arequipa, the "Sociedad Electrica de Arequipa" owns and operates a hydro-electric central station at a place called Charcani, about 11 kilometres from the town, the motive power for which is supplied by the Chile River, with a maximum capacity of 1,000 horse power. Current will be delivered at Arequipa over a three-phase line, at 5,400 volts, for power and lighting purposes, as soon as the installation is completed.

The intake flume, about 1,300 metres long, has a capacity of 4 cubic metres per second. With an available head of 26.5 metres, it is possible to develop a theoretical force of 1,413.33 horse power and an actual output at the water-wheel shaft of about 1,060 horse power. The original equipment consists of two turbines consuming 865 litres of water per second, and developing 248 horse power each, or a total of 496 horse power. Each wheel operates a single-phase, alternating-current, 50-cycle, 5,400-volt generator.

The high-tension current is carried over an eight-wire line into Arequipa, a distance of 12,500 metres, where it is converted to 110 volts at a sub-station, through sixteen static transformers of capacities varying between 2 and 20 kilowatts.

Arequipa today uses 10 1,000-candle-power arc lamps, and 4,391 incandescent lamps of different ratings, aggregating 77,972 candle

PANORAMA OF THE CITY OF AREQUIPA

power. The lighting service is, however, most unsatisfactory, owing to the insufficiency of the present equipment to meet requirements. As a result, the streets are half the time in the dark, and complaints from private subscribers are constant—the company being unable to supply the current contracted for and give satisfactory service, on the one hand, and the consumer trying to get even with the company, on the other, by using lamps on their circuits of double the rating that they are entitled to, in an effort to get a modicum of brilliancy.

The Sociedad Electrica de Arequipa, it must be admitted, is now installing an additional 500-horse-power equipment which should suffice for present requirements, although, as a matter of fact, an entirely new hydro-electric plant would be advisable in order to bring the light and power service up to the standard expected in a first-class city of the importance of Arequipa.

The Chile River is amply capable of furnishing all the motive power necessary for the purpose, representing, as it does, a colossal hydraulic force, hitherto overlooked.

Mr. Habich, director of the Technical School of Lima, in an article published in the bulletin of the Mines of Peru, in its issue of July 31, 1901, pointed out that Peru, with its rivers descending from elevations of 3,000, 4,000, and 5,000 metres, possessed incalculable sources of power, and showed that the Rimac River alone was capable of developing at least 100,000 horse power.

Returning to the River Chile itself, and basing calculations from a point a little above the location of the present station at Charcani, about 3,000 metres above sea level, this stream carries a volume of

water of 6 cubic metres per second, equal to a theoretical force of 240,000 horse power. By properly damming the Chile between Charcani and sea level it would be easy to develop a minimum effective power of 100,000 to 120,000 horse power.

The objection to such a scheme would be the fact that the water thus taken from the stream could only be used for irrigation after passing through the water-wheels, which, if installed at sea level, would render such utilization impossible, whereas the Peruvian Government is unequivocally opposed to the granting of any water rights whatever that would interfere with its plans for increased irrigation facilities. In the eastern part of Peru there is such an abundance of water that this restriction does not obtain, but on the seaboard it is necessary either to utilize the higher levels of the streams (up in the mountains), or to have recourse to partial and successive developments so as not to interfere with irrigation. For the specific case of Arequipa, the latter plan is the most practical.

By lowering the location of the present plant about 400 metres, it would be a simple matter to increase the head from the 26 metres now available, to at least 100 metres. This would in no wise prejudice irrigation, as there are no lands whatever under cultivation between the present and the proposed locations of the plant.

THE CHILE RIVER NEAR AREQUIPA.

By lengthening the present flume or ditch, a force of 4,000 horse power could be developed, while by building a new flume of sufficient capacity to carry the 6 cubic metres of which the Chile River disposes, a force of 6,000 horse power could be obtained.

With such a supply of electrical energy available, the electrification of the railroads of southern Peru would follow in due course, either totally or partially, creating a large market for power.

The Peruvian Southern Railroad operates 359 kilometres of road over an average grade of 1.3 per cent, between Mollendo, which is at sea level, and Crucero Alto, the highest point on the line, at an altitude of 4,840 metres.

Allowing 33⅓ per cent for losses from all sources, which is excessive, the remaining 4,000 horse power available would suffice to

THE HYDRAULIC CANAL ALONG THE CHILE RIVER.

move five trains of 70 tons each at a speed of 36 kilometres per hour, which is far in excess of present or ultimate traffic demands on the road, especially if tri-phase traction operation is adopted, when the returning cars on the down grade, instead of consuming, would on the contrary generate additional current, the motors being converted into generators. The total mileage of the road is not beyond the limit of economical electrical operation over high transmission lines, at the present day.

The next and by far the most important source of water-power supply of Peru is Lake Titicaca, lying 3,800 metres above the level of the sea, with a surface area of 6,600 square kilometres, and an average depth of 20 metres.

Lake Titicaca, as is well-known, is an isolated basin into which a great number of rivers empty. The outlet of this basin is the River Desaguadero, which discharges its waters into Pampa Aullagas, where they are lost through evaporation and filtration. There is a popular belief that a subterranean stream continues and discharges

THE PENSTOCKS AND POWER PLANT, CHARCANI.

into the sea, but scientific investigations have failed to substantiate the theory and it appears certain that this water is absorbed only by evaporation and filtration. The fact remains, however, that the Desaguadero River before entering the Pampa Aullagas carries a volume of 100 cubic metres of water per second, whereas the stream that serves as outlet to this lake has a volume of only 1 cubic metre per second. It is therefore evident that the greater part of the waters of the affluents of Lake Titicaca are lost through evaporation and filtration between the two lakes and the Desaguadero River.

The proportion of this loss due to evaporation returns in a measure to the drainage basin of Lake Titicaca in the form of rain, contributing in part only to the cycle here outlined.

LAKE TITICACA, AND THE ISLAS DEL SOL.

The project hereafter suggested, therefore, contemplates exclusively the utilization of the water actually wasted by filtration in Pampa Aullagas.

For various reasons, and especially for the purpose of utilizing this water for irrigation after leaving the turbines, it is desirable to have this water fall over the Pacific slope. Lake Titicaca lies in a hollow, surrounded on all sides by an unbroken ridge of mountains, ranging from 250 to 800 metres in height, presenting a formidable engineering problem which can be overcome by only two solutions; either tunnelling through the mountain, or pumping the water up and over the lowest practicable eminence.

The distance from Lake Titicaca to the Pacific Ocean, as the crow flies, is 250 kilometres.

According to surveys, the shortest practicable tunnel that could be bored through this natural barrier to the nearest valley, would be between 60 and 70 kilometres long; this, while entailing an enormous cost, would greatly shorten the transmission line.

As regards the alternative plan of pumping the water over the side of the mountains; it has elsewhere been mentioned that the highest point on the ridge immediately encircling the lake is Crucero Alto, at an elevation of 4,600 metres, or about 800 metres above the level of the lake. In the event of an actual undertaking of such an enterprise, a much lower point would of course be determined upon, after proper surveys; but for the purpose of demonstrating its feasibility, Crucero Alto will be selected as the peak to which the water must be

raised, and furthermore, the pipe line will be assumed to follow the tracks of the Peruvian Southern Railroad (a very much longer and more circuitous route than would be taken in practice), a total distance of 524 kilometres.

To raise 100 cubic metres of water one metre in one second requires 1,900 horse power with good pumps. The difference in levels between the surface of the lake and Crucero Alto being 800 metres, a force of $1,900 \times 800 = 1,520,000$ horse power would be necessary.

At first sight this figure appears appalling, but it will be shown hereafter that the available supply of power for the pumping station would be far in excess of this amount.

100 cubic metres of water under a head of 4,600 metres represent a theoretical force of 6,133,333 horse power which, after deducting 1,520,000 horse power consumed at the pumping station, would still leave a theoretical supply of 4,613,333 horse power to dispose of.

Assuming the penstock to be built of a number of pipes, each 1 metre in diameter and carrying a volume of 628.3 litres of water at a velocity of 0.8 metres per second, loss of head may be estimated at 1 metre per kilometre, or 524 metres for the entire line, equal to 698,666 horse power, to be deducted.

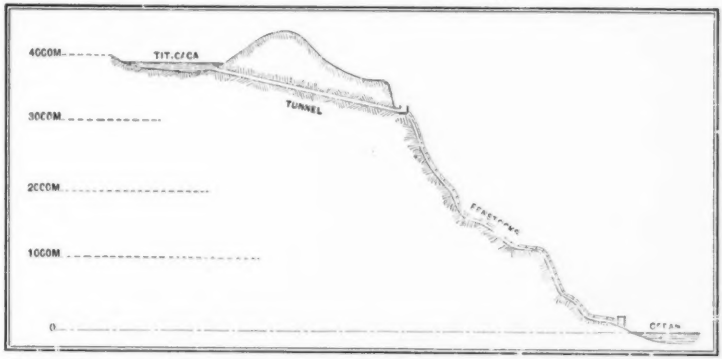


DIAGRAM OF TUNNEL PROJECT FOR USING HYDRAULIC POWER FROM LAKE TITICACA.

Further, allowing 1,914,667 horse power for losses from all sources, in the turbines, generators, etc. (which is extremely liberal), a net surplus of 2,000,000 horse power of electrical energy would be left available for sale.

The plan above suggested provides for the driving of the pumps by the electrical energy generated by their own initial action, but it must of course be understood that steam is contemplated as the

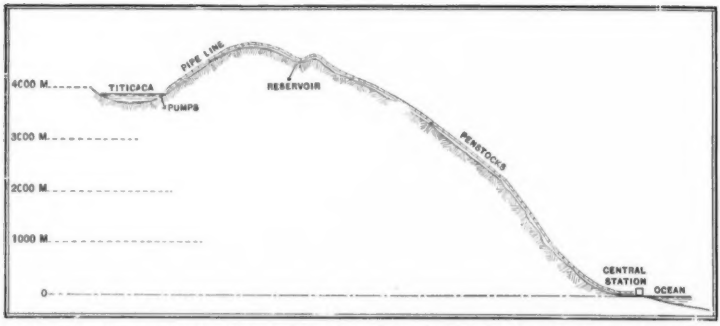


DIAGRAM OF PUMPING PROJECT FOR USING HYDRAULIC POWER FROM LAKE TITICACA.

original motive power at the pumping station. For example, a pumping station would first have to be installed on the edge of Lake Titicaca, at a suitable point such as Puno, driven by steam, with a capacity sufficient to force 1 cubic metre per second to a height of 800 metres. Such a pump would consume 1,520 horse power to perform the work.

This water would be pumped into a reservoir at Crucero-Alto, from which it would fall by gravity to sea-level, where it would develop, as above shown, an actual net force of 35,000 horse power of electrical energy, or more than double the power required to drive the pump at Titicaca. After supplying this power to the first pump, there would be a reserve force of 20,000 horse power left, which could be used to drive a second pump, and so on successively, until, with adequate capacity in the Crucero-Alto reservoir, one hundred pumps could be kept in automatic operation, delivering a net total of 35,000 — 15,000 × 100 = 2,000,000 horse power, as above demonstrated.

The market for this supply of power would be in its application to the electrification of present steam roads and the operation of new electric properties, mining and agricultural industries, public and private lighting, the manufacture of carbide of calcium at the coal mines, the operation of overhead conveying cables which are in general use in Peru, and for heating, household, and general power purposes.

A petition is now before Congress urging the appointment of a special commission to make surveys and reports on the feasibility of such a development and to prepare estimates on the probable cost of construction, with a view of drawing up a bill of conditions governing a concession under which foreign capital will be invited to undertake the project.

THE PREVENTION OF ELEVATOR ACCIDENTS.

By Reginald Pelham Bolton.

The elevator is generally recognized as one of the important elements in the problem of concentration and distribution of population—an element which throughout the United States has materially modified not only the external aspects of the cities, but their organic constitution. The question of safety in elevator-travel touches the individual interest of far more persons than that of safety in railway travel. Mr. Bolton is one of the leading specialists in the field, and his discussion is absolutely impartial and unbiassed.—THE EDITORS.

THIS title is familiar as a newspaper head-line, and, as such, covers descriptions of many occurrences which are in no sense properly termed accidents, being frequently used to cover accounts of mishaps which have nothing to do with the elevator apparatus, and of other occurrences which are merely functions of the machinery, such as sudden stoppages due to the application of safety appliances.

Of similarly incorrect description are many of the so-called "falls" of elevators, most of which are merely descents of cars within natural and designed conditions.

With such occurrences this paper is not intended to deal, but with the relatively small number of real "accidents"—by breakage, by derangement, or by the recklessness of operators. In view of the very large number and extreme variety of design of elevators, together with the adverse conditions under which very many are operated, these must be concluded to be an extremely small proportion.

The real accidents herein referred to are not, therefore, to be regarded as calculated to weaken the public confidence in the elevators in which so large a number of us now habitually travel, but rather to discuss the directions in which these isolated occurrences have indicated additional precautions, care, or modifications of experimental designs.

It may be premised that by far the large number of real accidental occurrences take place with the class of elevators used for freight, in which the general public is not personally involved, and the least number, and least proportion, attend the operation of the elevators of offices and other public buildings—a strong testimony

to their general excellence of construction, and to the ceaseless care of that modest class of men, the operating engineers of the buildings in which these hard-worked machines are installed.

It is to this constant vigilance, persistent care, and regular system of maintenance, that the safety of the vertically-traveling public is due; and in these matters due acknowledgment must be made of the unseen services of the inspectors of those companies who undertake the work of inspection in connection with the system of insurance, the only public evidences of which are the familiar little brass name plates attached to the interior of the cabs.

It is to the credit of American pre-eminence in this class of engineering work that the other familiar name plate—that of the great manufacturing concerns building these machines—is regarded, and properly so, as an additional high guarantee of security.

There are some fourteen companies in the elevator-insurance business, among which competition for the acquisition of "risks" is keen. The rates for passenger machines run up to about $30 per machine per annum, and cover the services of a staff of inspectors, maintained by most of the insuring concerns, or of the special staff of inspectors of the Otis Elevator Company. These inspectors form a class of very painstaking and experienced engineers, most of them having had personal experience in the construction, and many in the actual operating care of such machinery. Their routine work is well done, but they need to be reinforced by an educated and trained knowledge of elevator mechanics and theoretics.

The inspectors employed by the Building Department in New York city are altogether too few in number, and they have entirely too wide a field to cover to secure adequate inspection on their part. Their observations are necessarily rare, and frequently cursory. They would be of greater value if even less in number but more searching in character, as is the case in the annual overhauling of marine machinery, or the annual re-testing of boilers. The present methods neither encourage the best men to take the position of city inspectors, nor to do conscientious work, nor do they accomplish effective results.

The careful owner should, therefore, place little reliance on municipal inspection, much more upon company inspection, but most of all upon the responsibility of his own employees.

The keen competition between insuring companies, which has been referred to, is productive of a grave disadvantage to the cause of public security, because the insistence of an insuring inspection

department upon repairs, renewals, or alterations, may be followed by the economically-inclined owner withdrawing his insurance, and replacing it with some other company; under the existing conditions of competition in the risk-writing departments of these companies, this can readily be done. Thus it not infrequently results that the careful precautionary recommendations of responsible inspectors are negatived, and their good work fails of its object. There are enough ignorant and reckless men in ownership, or in charge of some of these machines, to make it of public interest that the directions and recommendations of the body of trained inspectors (which stand between that public and bodily injury) should be capable of enforcement, and it is deplorable that the exigencies of competitive business should be permitted to interfere with so vital a matter.

About a year and a half ago, I issued a circular letter to the insuring companies, inviting their attention to this subject and asking their views as to the desirability and probability of united action in refusing re-insurance of risks which were under criticism by the inspection department of another company.

Most of the replies were adverse to the probability of any such agreement being reached, but sufficient expressions of the great desirability of such action were received to lead to an invitation to a representative of each company to meet and discuss the matter. This meeting took place at the Astor House, New York city, on March 2, 1905, and was attended by the representatives of several of the leading concerns; they were united as to the shortcomings induced by the present competition, but were unable to suggest any remedy likely to be agreed upon. It can, therefore, only be hoped that the matter may be brought to a head by the action of competition itself, as has been the case in the ruinous competition of fire-insurance risks. My own suggestion is that a central committee, somewhat similar to the Board of Fire Underwriters, may be formed, which shall act as a board of reference in such matters.

Meanwhile, certain risks will continue to be incurred by the insuring companies, involving accompanying chance of danger to the public, in spite of the knowledge of the facts and the general opinion, which, as far as can be gathered, is held by many of their inspecting engineers—that some agreement should be reached in this matter.

The Building Department of New York city has some excellent regulations, which were promulgated in May, 1902; but most unfortunately these are not retroactive, so that conditions still obtain on many machines, particularly in the very numerous class of freight

apparatus, which it would be most desirable to amend. Some improvements have, however, been very properly secured through the officials' insistence on amendments, when elevators undergo any changes requiring their approval. Much has also been gained by the requirement of a certification of competency on the part of operators placed in charge of elevator machines, through this system is by no means fully developed or effective.

The city authorities of Philadelphia have exhibited a very energetic disposition in the matter of requiring the application of special apparatus of known security to public elevators, some of them being patented devices; from which course, the accusation of favoritism has not moved them, as it has, on several occasions, prevented the adoption of a similar course in the city of New York. Thus it has been made necessary for owners to secure the safety of the public by providing the highest and latest class of safety devices, speed governors, safety clutches, and, in addition, either the air-cushion or the wire friction device to receive the car in the remote chance of an absolute fall, or of a distinct downward over-running.

While there may be divergent opinions as to the relative effectiveness of such appliances, it remains most desirable that every known security should be brought to bear upon this class of machine, just as in the case of railroads the application of patented air-brakes has been demanded by law, and the demand has been approved by public opinion. These, or equivalent, securities should be carefully considered in connection with any new form of elevator machine which may be introduced; and this is the more so, since there is probably no class of engineering apparatus in which so many radical methods are constantly suggested, and so many schemes, some little better than fads, are tried. All of the many developments of the electrical operation of elevators have been more or less experimental, and the development has not yet reached an accepted form; while the known, and tried, and tested security of regular hydraulic-machine practice is, at present, being discounted in favor of an extreme development, on high runs, of the plunger type.

Conscientious shop construction is of prime importance, as is the conscientious selection of only the best materials. In elevators, however, the shop construction is only a part of the completed apparatus, and it is in the assemblage, erection, and adjustment, of the combined apparatus that the most particular care is desirable.

A brief account of some accidents, which were subjected to expert investigation by the writer, may be of interest as indicating the numerous directions in which care and precaution are required.

For obvious reasons, the name of the building is not given, and I regret that other occurrences of extremely interesting character are subjects of legal action at present, and cannot, therefore, be disclosed.

1.—Screw Electric Type.

Car with operator and one person on down run; two out of four hoist ropes pulled out of thimbles, and main head of the machine, with all the hoisting idler wheels upon it, broke off sideways, letting remaining ropes go slack; car descended two floors, when speed safety pawled; passengers uninjured.

Cause and Effect. Hoist ropes, when renewed, had been secured into thimbles by spreading the ends of the wires and filling them up with Babbitt metal. Unequal strain brought about by one slipping in the thimble gradually over-strained the other. Before parting, the first loose rope jumped groove on idler, and threw the entire load on the next rope; this parting, threw entire load to other side, which strain twisted off the head, and dropped all hoist ropes.

Moral: Secure the rope ends by binding over eyelets.

2.—Sidewalk Steam Freight Machine.

Man with packing case descending, platform descended unequally and tipped the man down the shaft, and case on top of him. Everything but position of one side chain was in order after the accident.

Cause and Effect. The man loaded the case on the platform so that one edge projected sideways over the head-wheels on that side; when platform descended, the case landed on the wheels and locked them, so that the chains could not run through, and so that side of the platform remained suspended, while the other descended.

Moral: All upper head-wheels at sidewalks should be cased over.

3.—Warehouse Steam Freight Machine.

Car ascending with number of employees, stopped, and fell from fourth floor, without being retarded or held by spring safety clutch, which was of old pattern, a laminated spring held off by two hoist ropes, chisel teeth on wood guides. Both hoist ropes broken at different lengths, one chewed off by getting in the spur gear, one torn violently apart; controlling and other small gear disarranged by one rope having twisted in it. Slack cable lever under drum all in good order.

Cause and Effect. One rope jumped groove in drum and rode on to the flange, slipped out between flange and slack cable lever, outer end, not entirely disengaging the trigger. Loose rope entangled in spur gear, hoisting the car up slightly, and slackening the other rope. First rope, chewed off by gear, drops car on to second slack rope, shock bursts second rope, car descends, but end of ropes wound in small gear, and weight of tail ends, retard spring on car from setting the clutches.

Moral: Speed governor safety needed on all elevators.

4.—Steam Warehouse Machine.

Car loaded with cases from door on street side; two men on inside, where hand rope and doors are situated. At third floor, car descends. Ropes found intact, but drum torn from its supports, one bearing having cap bolts torn out, the other support twisted off at foot.

Cause and Effect. The operator had loaded the packing case so that it projected over rear of car on street side, and caught against iron casing of window on that side, at third floor, stopping the car, while full steam on engine hauled on the drum; cap bolts broke before ropes parted. Drag of ropes prevented safety spring operating, as in No. 3.

Moral: Folding gate on all cars required.

5.—Electric Drum Machine.

Repairs to two machines, which are arranged right and left-handed, had been made, and the engineer was trying them over to adjust limit stops at end of down run; machine stops, then tears drum away from supports, complete wreck.

Cause and Effect. Passing from one to the other, the controls being reversed, he bottomed the back drum counter-weight, slacked the ropes; one jumped the other; on down run, the taut rope draws counter-weight up against overhead beam before the down limit stop goes in, drum hauls on ropes, and tears machine apart.

Moral: More space above counter-weights is desirable, and is specially required for all electric drum machines.

6.—Long-Run Plunger Machine.

Car with operator only, ascending, reverses and comes down at normal speed, as usual, with operator dead on floor, wound on head.

Cause and Effect. Combination of ram, counter-weight, and car being proportioned for a certain speed with full load, when running without that load it requires about fourteen to sixteen feet for a stop, after reversal. The operator, evidently, leaned out to close an open door on the up run, having reversed his machine, but the car continued on and struck him against lintel, after which it stopped, and being reversed, came down.

Moral: A limitation of up-run stopping distance to a distance not exceeding 8 feet.

7.—Express Hydraulic Machine.

Woman standing in front of car, caught in projecting gear in the shaft.

Cause and Effect. Numerous projections at each floor, and speed of car causing woman's clothing to swing out. Folding gate not closed by operator.

Moral: Folding gates that can be readily operated are desirable and operators should be compelled to use them.

8.—Belt-Driven Machine, Freight and Employees.

Ropes torn off drum, car descending, old spring safeties went in, but so violently as to tear away guides, and car went to the bottom.

Cause and Effect. Careless workman rolled heavy barrel of goods against belt gear.

Moral: Machines in factories should be placed in separate chamber.

9.—Hydraulic Pushing Machine, Freight and Employees.

Quite a full load of goods and men at top floor; part way down the car dropped, checked, dropped again, checked, then dropped to the bottom.

Machine piston rods were doubled up, ropes torn off on sharp edge of frame; spring safety had gone in, pulled out, again gone in lower down, and torn out.

Cause and Effect. Heavy load, car descends rapidly; operator reverses suddenly; strain buckles the piston, ropes slack off, car drops, safeties go in; ropes bring up taut, pull safety out, ropes burst, car drops; drag of ropes keeps safety out till ropes get over head wheels, then safety goes in, but strain tears it apart.

Moral: Sudden reversals at full speed bring heavy strains.

To be forewarned is to be forearmed, and these examples, with no doubt, a number of others, are now available to direct attention to the weak points of elevator construction and operation, and to illustrate the extreme variety of circumstances and conditions which have to be guarded against; they enforce the need, not only for good regulations, but for good training of operators, and for an active co-operation between owners, city authorities, and insurance companies on the subject of inspection.

It may be said that in this matter, as in that of our liberties, the price of security is eternal vigilance.

PATENTS AS A FACTOR IN A MANUFACTURING BUSINESS.

By Edwin J. Prindle, of the New York Bar.

IV. THE PATENT RELATIONS OF EMPLOYER AND EMPLOYEE.

In the article here presented, Mr. Prindle brings to a close the important synopsis of patent law as related to manufacturing interests which began in our September issue. The preceding sections have considered successively the part which patents may play in controlling markets, the protection they afford their owners, their effect in in legalizing trade combinations, and the study which should be made of patentable features before issuing a new product. The installment now presented deals with one of the most important principles of patent law as related to ordinary industrial organizations.—THE EDITORS.

THERE are three principal points to be considered in the patent relations of employer and employee as to inventions made by them. First, it is necessary to determine who in the eyes of the law is the actual inventor of a particular invention, because a patent is valid only when granted in the name of the inventor. The fact that some one else than the one who conceived the invention owns the right to the patent, or furnished the money with which the invention was developed, does not make him the inventor, and the patent would be invalid if granted in the name of the owner or the backer who did not participate in the inventive act. Second, where an employee is concerned in the making or development of an invention, it is necessary to determine whether or not the employer is entitled to the ownership of the patent granted on the employee's application and, therefore, to the right to prevent everyone else from making, using or selling the invention; and, third, if the employer is not entitled to the patent, whether he has a right himself to make, use, and sell the invention in competition with others who might, by the employee, be given rights under the patent.

EMPLOYEE'S INVENTIONS.

Many an inventor is not a mechanic, and is not even sufficiently practical to work out the details of an invention, so that it is necessary for him to employ the skill of some one else actually to construct the invention. A complete inventive act consists of a mental conception of the invention followed by a reduction of the invention to practice. If an employer forms a complete mental conception of the invention

and then has his employee construct the thing he has conceived, the employer is regarded as the inventor. The relation of employer and employee exists not only where a manufacturer uses his own regularly employed mechanic, but where any inventor employs any mechanic to reduce his invention to practice. In this sense a corporation employed to build a machine embodying an invention would be an employee as to the inventor. If there arises any controversy as to who made the invention, that is, as to whether the employer or the employee made the invention, the presumption is that the employer made it, and the employee must show by convincing proof that he made the invention before his claim will be entertained.

For instance, a shoe manufacturer had trouble with his operatives and found it desirable to have a machine for nailing the heel to the shoe which would be sufficiently perfect to require only a class of labor that could easily be trained, so that a strike of the trained operatives could be broken by training in new hands. He went to machinists and outlined a machine to accomplish his purpose. The manufacturer described the principal elements of the machine, and how they would work with relation to each other. When the machine was completed the machinists claimed to have invented certain features, and filed an application for patent in opposition to that of the manufacturer. The court held that where one is employed for the special purpose of carrying out the conception of another person, the one who builds the machine stands in the relation to the one who conceives it, of employee to employer, and there is a strong presumption that the machine, when completed, is the invention of the employer, and the court held that under the burden of that presumption, the machinists had failed to prove their case.

There was an inventor who had patented a reel for use in rod mills. He made a contract with an engineering company whereby the company undertook to install his reels wherever they had an opportunity, and the company also undertook to perfect the machine in its details. The president of the company improved the machine in its details and filed an application for patent for the improvement. The president obtained his patent before the inventor was aware of what had happened. The inventor, upon seeing the notice of the patent issued, filed an application for a patent for the same invention and claimed that he had disclosed the improvements to the president of the contracting company. The court held that the president of the company had put himself in the relation of employee to the inventor as employer, and that therefore the presumption was in favor of the in-

ventor and against the president, and granted a second patent to the inventor. Incidentally it may be observed that there were in this case two patents in existence for the same invention, one erroneously granted to the president of the contracting company, and the other rightfully granted to the inventor for the improvements. The Patent Office has no power to cancel a patent after it is granted, but there are provisions of the patent law under which a court can declare void erroneously issued patents, and in this way the patent to the president of the contracting company could be gotten out of the way. While it was in force, it would of course be more or less of a cloud on the patent to the inventor.

In order that the employer may be regarded as the inventor by the law, it is necessary that he do more than merely to suggest the desirability of an invention for a given purpose. He must not only suggest that desirability, but he must show, at least in a general way, how the machine, for instance, is to be constructed. If Edison had suggested to an employee that it was desirable to be able to transmit electricity with something less than two wires for every circuit, and his employee had conceived of the three-wire circuit, by which the middle wire serves both for the outgoing current of the one circuit and the incoming current of the other circuit, Edison would not have been the inventor, but the employee would have been. The idea is that until a person has actually conceived how to make an invention that will accomplish a given purpose, he has done the public no service to offer in return for a patent. The law provides only for the granting of patents to the original and first actual inventors.

Where the employer furnishes a complete conception of the invention, such, for instance, as would be evidenced by working drawings, there is no question that the employer is the inventor. It is often the case, however, that the employer has a general idea of how a successful invention could be built, but he is not sufficiently practical, or does not have the time, to work out minor features which still require some inventing as distinguished from the skill of the mechanic. He has an idea of the main features of a machine, for instance, and how they are to operate with relation to each other, but he does not know how to arrange the gearing for operating the main parts. The employer puts an employee to work on the problem, and perhaps a good deal of experimenting is necessary before a successful result is arrived at. In this case the law regards the employer not only as the owner of the entire invention, but as the actual inventor of the details which the employee worked out. They are properly included in a patent granted to the employer as the sole inventor.

Where the employee's suggestions are so separate from the invention of the employer that they form in themselves complete inventions and are not merely auxiliary or tributary to the main invention, the employee is regarded as the inventor.

In Whose Names Patents Are to be Taken.

The law provides for the granting of patents only to the actual inventor of the patented invention, and a patent granted in the name of any one else is invalid. For this reason it is essential that the application for patent be made in the name of the one whom the law regards as the inventor. In some factories it is the custom to patent every invention in the name of the president of the company. This frequently happens because the company has been built up on inventions made by the president or other officer, and as a matter of pride the president wishes to see all patents issued in his name. This is a dangerous thing to do in the case of inventions which were conceived by the employee independently of the officer, such as inventions wholly worked out by employee without suggestion or assistance from the officer; for if, in a suit brought under such patent, it were shown that while the patent was granted in the name of the officer, the invention was actually made by an employee, the patent would be declared invalid, and usually a suit would not have reached such a stage until it was too late to go back and patent the invention in the name of the real inventor. This would be because a valid patent cannot be obtained on an application for patent filed more than two years after the invention has gone into public use in the United States, or after specimens of the invention have been placed on sale in the country. There are other bars which also might prevent the grant of a patent at the time mentioned; such as the fact that a description of the invention might have appeared in a publication for more than two years. The description would, however, have to be so full and complete that any person skilled in the art could make and use the invention from the knowledge furnished by the description alone, and without the exercise of the inventive faculty.

Invention Made by an Employee.

Where an employer employs clever men and has them instructed in the details of his business, he lays himself peculiarly open to the possibility that his employees may make inventions which would seriously hurt his business if he had to compete with them. It therefore becomes exceedingly important to consider what are the employer's rights under these circumstances.

The mere fact that an inventor is in the employ of another when

he makes an invention does not give his employer any claims upon his invention. If, for instance, the employee makes an invention out of working hours and in his own home, and does not use the time or materials or employees of his employer in perfecting the invention, the employer, in the absence of a contract, has no claim whatever on the invention even though it relates to the employer's business.

Supposing, however, the employee makes an invention in the shops of his employer, and perfects it there, using his employer's time and materials, and the assistance of his fellow-employees in perfecting the invention. There are two things to be considered: first, the employer's right to make, use, and sell the invention; and second, his right to a monopoly of the invention—that is, his right to exclude others from making or using or selling the invention. Under the circumstances which I have supposed, the courts have held that an employer acquires a shop-right or a license to make and use the invention in his own shops and to sell the articles so made; but he does not, in the absence of a contract, acquire any right to the title to a patent on the invention, and therefore does not acquire any right to prevent others from making or using or selling the patented invention. The employee can license his employer's competitors to make and use and sell the same invention, and thus thereby create all the competition that is possible, but the employee can never enjoin his employer from making or using or selling the invention.

Even where the inventor is specially employed to invent, unless the contract unequivocally provides that the title to patents on the inventions shall be assigned to the employer, the employer cannot compel an assignment of the invention. A couple of examples of adjudicated cases will make this matter clearer:

An employee of a watch-case manufacturing company was working as a tool-maker when, as the company alleged, he came to the president and stated orally that if his wages were increased (from $25 to $30) he believed he could make improvements that would be valuable. No written contract was made. The employee's wages were increased and he was given men and materials to carry out his ideas. The improvements were successfully made, and an application for patent was made, the company paying the expenses connected with it. The patent issued to the employee and the company demanded an assignment to the company, claiming that the employee had agreed that, if the company would pay the expenses of the patent, he would assign it to the company without further consideration than his increased wages. The employee denied that he had ever agreed

to assign the patent to the company, and left the employ of the company. The company brought a suit to compel an assignment of the patent. The Supreme Court of the United States refused to compel an assignment of the patent, holding that it would only compel such action in cases where a contract to assign the patent had been clearly proven, and that it was improbable the employee had offered to assign the patent, merely if the company would pay the expenses of obtaining it, and without any benefit to himself, such as a covenant to employ him for a stated period and at a stated salary.

One Hansen was chief engineer of a company making pressed-steel cars, at a salary beginning with $4,000 and running up finally to $10,000 per year. The company contended that at the time Hansen entered its employ, there was an oral agreement that all inventions and improvements he might make while in its employ, and any patents obtained thereon, should belong to the company. There was, however, no written contract, and Hansen denied having made any oral contract. During his employment, many inventions were made by Hansen and during the early part of the employment Hansen assigned all the patents he obtained to the company. When he finally left its employ, there were six applications pending in the Patent Office for inventions Hansen had made during his employment. These applications had been prepared by the company's attorney at the company's expense. The company demanded that Hansen assign these applications to the company, but he refused to do so. Suit was brought to compel an assignment; but Hansen resisted, saying he had assigned the earlier patents and applications, because he was young and did not realize his rights, but that was no reason why he should assign the remaining ones. The six inventions in question, Hansen said, were worked out by him in his own home and not at the company's shops. The United States Circuit Court of Appeals held that no contract was proven and refused to compel an assignment of the applications. Then the company contended that the mere relation of employer and employee, coupled with the fact that Hansen admitted it was part of his duty to design and improve the products of the company, gave it a right to the title to the patents. But the court held that nothing short of an express contract to assign the patents to the company could give the company a right to the title to the patents, whatever might be its right to a shop right or an unassignable license. The Supreme Court of the United States has decided that even a Government employee who invented a self-cancelling revenue stamp (using Government employees and materials to work

it out) and afterwards patented it, is entitled to the ownership of the patent, subject to a license to the Government to make and use the stamp.

Where, however, an employee agrees to assign to an employer patents upon any inventions which he may make while in his employment, even though the only consideration for the contract is the salary which the employee is to receive, and even though that salary is not larger than it would otherwise be, the courts will enforce the contract. I refer to two specific cases of contracts of this sort, which have been sustained by the courts.

A machinist made the following contract with a company manufacturing cigarette machines:

> "That the said company has this day employed the said Hulse to set up and operate its cigarette machines at a salary of $50 for the first month, and $65 per month thereafter, with such advance of salary up to not exceeding $75 per month as the services of the said Hulse may justify. . . . The said Hulse agrees to do all in his power to promote the interests of the said company, and in case he can make any improvements in cigarette machines, whether the same be made while in the employment of the said company or at any time thereafter, the same shall be for the exclusive use of the said company. And it is agreed that in case the said Hulse be not able to serve the said company sufficiently, or shall in any way neglect his duty, the company may stop his services at any time, paying up to such time; but in case the said Hulse desires to quit the said company, he shall give sixty days notice thereof."

After this contract was executed, Hulse made an improvement in cigarette machines, patented it, and demanded $100,000 from the company for it. The United States Court of Appeals held the contract to entitle the company to the title to the patent. The Court did not decide whether the provision covering inventions made after leaving the employment of the company was valid, as that was not involved in the case.

A man named Franzen entered the employ of a company manufacturing wire-glass, or glass having wire imbedded in it to strengthen it. The salary was $100 per month, and before beginning work Franzen signed a contract containing the following provisions:

> "First. The employer is engaged in the manufacture of glass, glassware, and mechanical devices in connection therewith, and that such manufacture is carried on by means of certain secret formulas, methods, processes, tools, machinery, patterns, and appliances, and the same are the property of the employer, and intended to be kept and guarded by the employer as secrets; and that all knowledge and information which the employee now possesses, or shall hereafter acquire, respecting such secrets, and all inventions and discoveries made by said employee during the term of his employment, shall at all times, and for all purposes, be regarded as acquired, and held by the employee in a fiduciary capacity, and solely for the benefit of the employer."

"Fourth. That the employee will, when required, make and execute any and all assignments in writing which may be deemed by the employer proper and necessary to transfer and vest in the employer the entire, right, title, and interest in all inventions and discoveries made by the employee during the term of his employment."

The employee finally left the employ of the company and forty days afterwards applied for a patent for a method of making wire-glass. The company brought suit to compel him to assign the patent to the company. Franzen contended that he had made the invention before he entered the employ of the company. It was shown that he had made statements to various employees that he had never seen wire-glass made before he saw it made at the works of the present company. It was also shown that on Sunday night, after midnight, and outside of the regular working time of the factory, he got the night engineer to start the engine, and that he made wire-glass with the company's machinery according to his process. Each of the three persons who were present was cautioned to keep the matter secret. The court found that the invention was made during the period of employment, and also held that the contract was mutual and was proper and necessary for the protection of the company's business, and that it was, therefore, not invalid on the ground of public policy, and a decree was granted, compelling the employee to assign the patent to the company.

The following is a contract which not only provided that the employee should assign to an employer inventions made during his employment, but also provided that if the employer did not wish to patent any of the inventions, the employee should keep them secret.

"Whereas, Herbert L. Hildreth, of Boston, candy manufacturer, is desirous of having perfected and manufactured a certain machine or machines for use in the manufacture of candy, and especially for sizing, shaping, cutting, wrapping, and packing, also the pulling of molasses candy, and whereas I, Charles Thibodeau, being a skilled mechanic, am desirous of entering the employ of said Hildreth for the purpose of constructing, improving and perfecting such machinery: Now, therefore, in consideration of such employment, and of the payment of wages to me at the rate of ($3.25) three dollars and twenty-five cents per day, I hereby agree with said Hildreth to enter his employ, and that I will give him my best services, and also the full benefit and enjoyment of any and all inventions or improvements which I have made or may hereafter make relating to machines or devices pertaining to said Hildreth's business. I also further agree that should said Hildreth not desire to patent any of said inventions or improvements, but to keep same secret, I will do all in my power to assist him in this, and will not disclose any information as to the same, or any of them, except at the request of the said Hildreth."

The employee claimed to have made an invention during the employment, and made application for a patent thereon. The employer

brought a bill to compel an assignment of the application, and the employee retaliated with a cross-bill asking for the delivery up and cancellation of the contract on the ground that it was unconscionable. The court held that the contract was valid and was but a proper protection of the employer's business, and that the employee was bound to keep perpetually secret inventions made during the period of employment.

The courts realize the extent to which an employer is open to attacks by his employees in the line of inventions and are quick to protect him within the limits I have stated. There was an employee of a veneer manufacturer who invented an improved veneer-cutting machine and sold the patent to his employer. The employee afterwards went to another city and, stating to some capitalists that he knew the patent was invalid, offered to build a number of such machines for them. The employee then went to the machinists who had made the veneer-cutting machines for the employer, and got a casting made from his employer's pattern of the principal part of the machine, and this casting was shipped to the other city. The employer put detectives on the matter and traced the pattern, and found that a machine was completed and was ready for shipment to the timber district. The court granted a temporary restraining order, enjoining the employee and the capitalists and the machinists who had made the machine, from moving the machine until the employer's rights had been settled. The employee would never be heard to state that the patent he had sold for a valuable consideration was invalid, because he would then be seeking to destroy the value of that for which he had received pay, and the capitalists were not permitted to use the machine, because they had associated themselves with the employee.

In view of the foregoing it is evident that it is desirable to have a contract with every employee who is at all likely to make inventions which relate to the business of the employer, and as the courts will sustain such contracts, even though they contain no further provision for return for the inventions than the payment of the ordinary salary, the employer should have such a contract with every such employee. There are manufacturing concerns where every man in the drafting room and in the sales department, and every skilled employee, is under such a contract. The difficulty of inducing the employees to sign such a contract will be reduced if the officers of the company will set the example by signing such a contract. This is often a mere matter of form, as the officer is frequently a man who is either not inventive, or

one who is glad to take his returns in the form of dividends from the stock.

EMPLOYER'S AND EMPLOYEE'S LIABILITIES AS TO INFRINGEMENT.

Where an employer directs an employee to make, use or sell an invention which is the subject of a patent, the employer himself is liable in an action for infringement on the principle that what one does through another he does by himself. And even where an employee commits an act of infringement for the benefit of his employer but without the knowledge of his employer, the employer is still liable, if he afterwards approves of the act, or knowingly takes benefit from the act, such as taking the profits from the sale of a machine. In considering the liability of the employer for damages, it is immaterial that he did not know that the act was an infringement of a patent. If the employee is one vested with discretion as to the conduct of the business, and he directs or commits an act of infringement, the courts in many circuits hold that the employee, as well as the company, may be enjoined. Thus, a sales agent selling goods on commission may be enjoined. A foreman of a factory is liable for infringements which he directs. But a mechanic who commits an act of infringement at the command of his employer is not liable in damages, although he may be restrained with the employer.

This paper concludes the present series of articles. As I stated at the outset, my purpose was not to make the manufacturer his own lawyer. But I aimed to give manufacturers a better idea of the nature of a patent; of the protection it affords or may afford; of the great adaptability of patents to different commercial conditions and forms of transactions; of some of the many ways in which the courts will thwart attempts to get the benefit of an invention without the consent of the patentee; and of the ways in which the manufacturer's patent relations with his employee can be rendered safe, and fully protected. The patent system of the United States is the result of over three hundred years of legislation and of interpretation by the courts, beginning with the reign of James the First in England, and it must be evident from what little has been shown by the foregoing articles that a system has been worked out that is thoroughly practical and that provides for every reasonable contingency. Whether or not a manufacturer likes the idea of patents, they are in existence in large numbers, and they enter into almost every line of business; he must reckon with them whether he will or not. It is therefore necessary that he have some understanding of the subject, such as it has been the object of these articles to afford.

EDITORIAL COMMENT

THE difference between the professional and the political attitude toward great constructive works was startlingly illustrated in the recent campaign. To the minds of the party leaders in New York State, an undertaking of the responsibility and significance of the barge canal is merely a vast opportunity for "patronage"—a crib from which so many followers might be nourished that the control of it means secure confirmation in power for the party which can seize upon it. And this conception is tacitly accepted by press and public.

That it should stand for a moment in the mind of the engineer, in or out of office, is unthinkable. His training is found in other schools, and his ideals rest on higher planes. Imagine a distinguished specialist being advanced for the post of chief engineer of one of our large railways, by a coterie who openly discussed before the board of directors the "patronage" their candidate would dispense after his appointment!

The situation created by the politicians' idea of the obligations of the State engineer must be most distressing to the officials most concerned.

* * *

The President's visit to the Isthmus goes no further beyond precedent than its consequences do beyond possibility of forecast; but nobody who knows anything of Mr. Roosevelt can doubt that his attitude and conduct toward the work will be strongly affected by his brief personal contact with it — too strongly, perhaps, considering how very brief that contact was and how incomplete the concept of so huge an undertaking must be under the conditions.

The influence upon Administrative policy so far most positively displayed, however, is the determination, voiced in the President's cable from Panama, to carry out a policy over which the President and his advisers have lately been hesitating and "to place the chief engineer in absolute charge in Panama," and this appeals so powerfully to reason and common-sense that it augurs well for the future. Incidentally, it may be remembered that it is precisely the course advocated by Mr. John F. Wallace months ago, and at that time received with scanty respect by Washington officialdom. May all Mr. Roosevelt's orders based upon his observations in the Canal zone be as sound and sensible!

* * *

There seems to be in progress a rapid and most fortunate awakening to our need of better opportunities and facilities for industrial education, and of the very grave import of the matter in its bearings upon our National economy and our international relations in industry. Few single passages in Mr. Louis J. Magee's able analysis of "The American and the German 'Peril'", which we published recently,* attracted more comment or were more widely quoted than that in which he traced the spirit and the outward organization of Germany's educational system, and outlined the marvellous variety of training she provides for her manual and mechanical workers.

The barrenness of our own attempts —or at least, their total inadequacy in perhaps the most important field—is strongly presented by Mr. Becker in his leading article in this issue. The defect attacks the very foundation of our much prized industrial supremacy. It imperils the whole future of the American mechanic, the originator of those manufacturing methods which put us in the van of the world, but which now (as

* THE ENGINEERING MAGAZINE, Jan.-March, 1906

Dr. Louis Bell pointed out in these pages last September) are no longer secure against thoroughly equipped Continental rivals.

We are glad, therefore, to see that the movement for an active reform and revivification in our systems of industrial education has taken a definite and organized form, under auspices which promise energy and permanent effect. The Society for the Promotion of Industrial Education held its first meeting at Cooper Union on November 16, and organized with Dr. Henry S. Pritchett as president, Mr. M. W. Alexander, of the General Electric Company, as vice-president, Mr. V. Everit Macy as treasurer, and Prof. C. R. Richards, of Teachers' College, as acting secretary. The board of managers includes twenty-seven of the best known manufacturers, educators, and technical journalists in the country. Three grades of members were provided for—regular members contributing $2.00 a year, contributing members paying $25.00 annually, and life members making a single payment of $250.00. The purposes so far as outlined are stimulation and education of the public interest in the subject, co-operation with manufacturers in establishing and developing schools or classes for their apprentices, or in arranging for their attendance on courses elsewhere, and in general, the assembling, in one institution, of the accumulated experience of all those who are striving along the same line.

* * *

Many of the measures for the control of offending corporations, which have lately an unusually large part of the work of our National and State legislatures, seem to find serious and most unnecessary trouble over the question of "Court review." The fundamental idea in most of them is excellent—a resumption of the right of visitation, a requirement of the publicity, which should never have been allowed to fall into lapse. But surely there should be lawyers enough in our legislative bodies to leaven the whole with the knowledge that the right of "Court review" is inherent and constitutional and can not be denied or abridged. Every man is entitled to his "day in Court," and the attempt to shut him off can only result, as in the case of the New York gas companies and the 80-cent rate bill, in the Court's emphatic assertion of its indefeasible prerogative. The law which attempted, by heavy penalties, to forbid the corporation to appeal to the Court for review, was itself suspended by that Court. In fact, no law of the kind will be fully operative until it has been interpreted and construed by the Courts. It would seem better worth while to spend time and thought upon framing a measure that will stand, than upon debating whether or not to grant the parties at whom the legislation is aimed a right which can never, by any means, be withheld or taken away.

* * *

Through a misconstruction of the legend on the drawings of the Edison Portland Cement Company's works which appeared on pages 213 and 214 of our November number, the credit for the design was given to Mr. Watson Vredenburgh Jr. The system was devised and the plant designed by Mr. Thomas A. Edison, and the drawings only prepared by Mr. Vredenburgh in connection with a report upon the plant after it was complete.

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Mr. Albert Spies terminated his long-standing relation with Cassier's Magazine on November 17. The December issue was the last produced under his editorship. With the January number the publication will appear under the editorial direction of Mr. Henry Harrison Suplee, who for nine years past has been in charge of the Review and Index departments of THE ENGINEERING MAGAZINE.

Our sincere good wishes go with our late associate in his new undertaking.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

UNIVERSITY AND SHOP TRAINING.

A COMPARISON OF UNIVERSITY AND INDUSTRIAL DISCIPLINE AND METHODS FOR TECHNICAL TRAINING.

Frederick W. Taylor—Engineering News.

AT the dedication of the new Engineering Building of the University of Pennsylvania Mr. Frederick W. Taylor, the President of the American Society of Mechanical Engineers, delivered an address containing some valuable opinions as to the training of engineers, and from a report of this address in *Engineering News* we make some abstract and comment.

Mr. Taylor states at the beginning that he views college education from the position of the employer rather than of the educator, a position which gives his remarks additional value from the very reason that this point is so infrequently taken. He considers the college graduate with regard to his future success in commercial engineering and industrial enterprises.

Taking first the period of the two years of practical life immediately following graduation, Mr. Taylor shows that in general it is unsatisfactory both to the young men and to their employers. The recent graduate finds his work more or less irksome, his employer unappreciative, unjust, and tyrannical, and his surroundings uncongenial, and it is only after a period of working contact with the commercial and industrial world that he gets shaken down to contented usefulness. In like manner the employer finds the new graduate unsatisfactory, and while preference is shown to technical graduates, the desire is for those who have been out of the university for more than two years.

In inquiring for the reason for this state of affairs, Mr. Taylor finds it largely due to the sudden change from years spent in absorbing and assimilating knowledge to the new occupation of giving out and using it. To a still greater degree, however, it appears to be caused by the lack of discipline, and to the lack of direct, earnest, and logical purpose which accompanies, to a large extent, modern university life.

Mr. Taylor maintains that the period of a young man's life in the university is one in which he is subjected to less discipline and given greater liberty than ever before or after. The knowledge that he can flagrantly neglect his duties sixty times in one term before any attention will be paid to it compares most unfavorably with the fact that two or three such offenses would be sufficient cause for dismissal from an industrial establishment.

The freedom of elective courses is also discussed by Mr. Taylor, and he refuses to admit that boys from eighteen to twenty years of age have the knowledge and experience necessary to select a logical and well-rounded course of studies. Even if they had the wisdom to select such a course, the temptation to choose those studies which come easiest to them is too great to be resisted in most instances. The freedom to study much or little, as it may be felt acceptable to the student himself also permits an irregularity of work which will never be allowed to him in later life, the life for which his training is supposed to be preparing him.

"During the past thirty years two radical changes have occurred in educational

methods. The kindergarten and its accompanying ideas has come for the children, and for the young men has come the change from the college, with its one or two courses carefully selected and rigidly prescribed by the faculty, to the university with as many different courses as there are young men, and in which under the elective system each student is given the choice of all of his studies.

"The fundamental idea back of the change from college to university is excellent; namely, that of providing a far greater variety in the courses to suit the different tastes and abilities of the students, and to especially prepare them for their future occupations. Accompanying, however, this great step in advance, and yet, so far as I can see, in no way logically connected with it, has come the false step of giving our young men in many ways a greater liberty than is allowed, on the whole, to any other class of active workers; and of handing over to them the final decision in a subject most needing a master mind.

"Commercial, manufacturing and other enterprises in which many men cooperate, are managed more and more by delegating all important decisions to a few men whose judgment has been trained through long experience, study and observation in those matters which they are called upon to decide. Yet many of our universities are managed by giving over to the young man, under the elective system, the final decision as to what studies will best fit him for his life's work, although he has, of necessity, but the vaguest idea of the nature of the subjects which lie before him. It is almost like asking him to lift himself up by his boot straps."

Both the elective idea in the university, and the kindergarten plan in primary education are excellent for the consideration of the parent, or other older person, but Mr. Taylor holds firmly to the good old idea that the student should believe it to be his duty to learn, rather than that it is the duty of the teacher to teach him. When the young man becomes imbued with the idea that he should be left free to develop naturally, he very promptly translates this idea into the wish to do only, or mainly, those things which he likes, or which come easy to him.

"Of all the habits and principles which make for success in a young man, the most useful in the determination to do and to do right all of those things which come his way each day, whether they are agreeable or disagreeable; and the ability to do this is best acquired through long practice in doggedly doing along with that which is agreeable a lot of things which are tiresome and monotonous, and which one does not like.

"Now neither the kindergarten idea, the university elective system, nor the lax college discipline tend to develop this all important habit in young men.

"We must remember that of all classes in the community, college boys are being trained to fill some day the position of leaders in the co-operative field. And there is no fact better established than that the man who has not learned promptly and fully to obey an order is not fit to give one."

In examining the careers of those men who have become successful in commercial and industrial affairs it appears that they are, generally speaking, neither learned men nor men of great intellect. Rather are they men of singleness and earnestness of purpose, men who have acquired by long training those habits, both mental and physical, which make them masters over themselves, together with a firm determination to pay the price for success in hard work and self-denial.

"In facing this question I would call attention to one class of young men who are almost universally imbued with such a purpose; namely, those who, through necessity or otherwise, have come into close contact and direct competition with men working for a living. These young men acquire a truly earnest purpose. They see the reality of life, they have a strong foretaste of the struggle ahead of them, and they come to the university with a determination to get something practical from the college training which they can use later in their competition with men.

"They are in great demand after graduating, and as a class make themselves useful almost from the day that they start in to work.

"Neither their earnestness of purpose, however, nor their immediate usefulness, comes from any technical knowledge which

they have acquired while working outside of the university, but rather from having early brought home to them the nature of the great problem they must face after graduating. Nothing but contact with work and actual competition with men struggling for a living will teach them this. It cannot be theorized over or lectured upon, or taught in the school-workshop or laboratory.

"I look upon this actual work and competition with men working for a living as of such great value in developing earnestness of purpose that it would seem to me time well spent for each student, say, at the end of the Freshman year, to be handed over by the university for a period of six months to some commercial, engineering or manufacturing establishment; there to work as an employee at whatever job is given him, either manual or other work. He should have the same hours and be under the same discipline as all other employees, and should receive no favors. Moreover, he should be obliged to stay even a longer time than six months unless he has given satisfaction to his employers."

It has been maintained in some quarters that the necessary practical training can be obtained in the college laboratory, but the operations of the two establishments are essentially different, and it is only in the shop in actual contact with workingmen that the young man can realize that the shop man is naturally about as smart as he is, and that the only way of getting above him is to add the real shop experience to the real college training.

"Let me repeat in conclusion that our college graduates are the best picked body of men in the community. Yet I believe that it is possible so to train young men that they will be useful to their employers almost from the day that they leave college; so that they will be reasonably satisfied with their new work instead of discontented; and to place them upon graduating one or two years nearer success than they now are; and that this can best be accomplished by giving them an earnest purpose through six months' contact early in their college life with men working for a living; by rigidly prescribing a course of studies carefully and logically selected, and with some definite object in view, and by subjecting them to a discipline comparable with that adopted by the rest of the world."

SPEED TRIALS OF THE DREADNOUGHT.

DATA AND RESULTS OF THE TRIALS OF THE PROPELLING MACHINERY OF THE BATTLESHIP DREADNOUGHT.

The Engineer.

IN view of the interest which is attached to the latest and most powerful addition to the British navy the information concerning the behaviour of the propelling machinery, as developed in the recent speed trials, demands notice and comment. The results of the trials are tabulated with considerable completeness in a recent issue of the *Engineer*, together with some details of the machinery which have not been fully made public before this, and hence we give an abstract of the account and a summary of the tabular matter.

Apart from the importance of the vessel viewed as the latest development of the fighting machine, the Dreadnought represents the greatest step which has yet been taken in the replacement of the reciprocating engine by the steam turbine. In land installations for commercial power stations the question of the first cost of the machinery plays an important part in the choice of the type of motive power, but in the naval service dividends do not have to be considered, or rather the dividend is declared when the victory is won, or when, because of the efficiency of the fleet the battle does not have to be fought at all.

The power equipment of the Dreadnought includes the machinery covered by the following description, the turbines being, of course, of the Parsons type:

"She has eighteen Babcock and Wilcox boilers, each of twenty elements, arranged in three stokeholds, and fitted for burning oil fuel in conjunction with coal. The grate surface is 1560 square feet, the heating surface 55,400 square feet, and the tops of her funnels are about 85ft. above the fire-bars. Each stokehold has a tube, about 30in.

diameter, which can be used for raising ashes, or wounded, by electric lifts. See's ash ejectors are also fitted. Each stokehold is self-contained.

"The main condensers have 26,000 square feet of cooling surface, the auxiliary condensers 6000. There are four propeller shafts, all the four capable of going ahead or astern in pairs. The wing shafts have each two turbines on them, one high-pressure ahead turbine and one high-pressure astern turbine; the inner shafts have each three turbines on them, cruising, low pressure ahead, and low-pressure astern. The wing propellers are ahead of the inner propellers. The construction of the rotors is generally known; these have been carefully balanced under steam, and can run up to a speed of 400 revolutions per minute, and each shaft has a governor fitted.

"The very high quality of work, the exactitude of the workmanship, have been noted by all who have seen the turbine machinery in Vickers, Sons, and Maxim's works. It may be of interest to mention that each of the cruising turbines has 39,600 blades in it, and the total number in all the turbines is in proportion. One feature in turbine machinery is the immensity of the exhaust pipes, each of the Dreadnought's exhaust pipes being a rectangle 12ft. by 4ft.—this for 11,500 horse-power. The system of dry and wet air pumps is well known.

"Whilst the Dreadnought was under construction and some doubts as to her success existed there were excellent reasons for saying as little as might be about her. Now, however, the ship has proved herself so entirely successful that the facts are practically public property."

The diameters of the high-pressure and cruising rotors of the turbines are 5ft. 8in., those for the ahead machines being 8ft. 7in. long, and for the astern motion 3ft. long, while the low-pressure rotor is 7ft. 8in. diameter and 6ft. 6in. long. A better idea of the mechanical problems connected with the mounting of these portions of the machinery will be gained when it is understood that the actual weight of the revolving rotors on one shaft is about 32 tons, so that the necessity for accurate balancing will be evident.

The displacement of the Dreadnought is given as 18,000 tons, and the powering was designed to be 23,000 horse-power, at the full speed of 21 knots. At this speed the coal consumption was computed to be 34,500 pounds per hour.

"The horse-power of the engines was measured directly by means of Denny and Johnson's torsion meters. This apparatus depends for its action upon the measurement of the angular distortion of the shaft itself. The shaft is thus converted into a transmission dynamometer, and the power passing through it is easily found. The apparatus consists of two discs or wheels of gun-metal keyed to the shaft at a suitable distance apart. Each disc carries one or more—generally one—permanent magnet, with the pole sharpened to a knife edge projecting from its periphery. Immediately underneath each disc is a stand containing a number of independent coils of insulated wire. Wires from the coils are led to a telephone which has differential winding. It is so arranged that if the shaft rotates without any distortion the permanent magnets pass simultaneously two coils, one in each stand, which are paired. The result is that absolutely simultaneous currents pass through the differential windings of the telephone, and the receiver does not speak. Suppose now that the shaft twists, then one magnet will pass one of a pair of coils before the other, and the telephone will tick for each one. But, by means of a suitable switch and contact studs, various coils out of the numbers on the stands can be paired together, and there is little difficulty in finding two which are the correct angular distance apart. As soon as this happens the telephone ceases to speak. The angular distortion of the length of shaft taken is then read off the instrument, and, being multiplied by a constant, gives the power that is being transmitted."

The details of the trials are tabulated very fully in the report already referred to, but some abstract of the figures is here given:

At a speed of 13 knots, the propeller shafts running at speeds of 175 to 200 revolutions per minute, the engines developed 5,000 horse power total, the boilers evaporating 10 pounds of water per pound of coal, and the steam condensed per horse power per hour from the main engines was

20.8 pounds. With a development of 17,698 horse power, the speed rose to 19.42 knots, while with the full development of 23,000 horse power the speed of 21.25 knots was attained. Four runs on the measured mile at maximum power gave a speed of 21.6 knots with a development of 27,518 horse power, the propeller speeds ranging, in this trial, from 320 to 355 revolutions.

At the full development of 23,000 horse power, the powering for which the turbines were designed, the steam condensed per horse power per hour was 17.01 pounds, and it must be remembered that this is practically the steam per effective horse power, measured on the shaft, as described above.

Further developments and fuller reports of the behaviour of this important installation of naval machinery will doubtless be made public later, but sufficient is contained in the reports already available to show that the steam turbine has made its place in the great battle ship, and that the other naval nations of the world will have to follow the example of Great Britain in this as in many other things if they are to maintain their standing as first-class powers.

BRITTLENESS IN BOILER PLATES.

A STUDY OF THE CAUSES OF BRITTLENESS IN STEEL AND OF FRACTURES IN STEAM BOILER PLATES.

C. E. Stromeyer—Manchester Steam Users' Association.

WITH the replacement of wrought iron by mild steel for boiler plates there has developed a number of peculiar cases of fracture, due, doubtless, to various causes. Improvements in the manufacture of steel have removed many of the defects of the earlier material, but there are still remaining instances of defects caused by brittleness, which have not been satisfactorily explained. In the annual report of Mr. C. E. Stromeyer, the chief engineer of the Manchester Steam Users' Association, some of these cases are discussed, with the idea of enabling the boiler maker to discover, if possible, the doubtful material before it is used in construction.

"When at the end of the seventies, mild qualities of steel were first made in the open-hearth furnace, it was hoped that a more reliable substitute had been found for iron than Bessemer steel could claim to be; and after a short experience, especially on war vessels, the French and English Admiralties, followed by Lloyd's Register, fixed on certain quality tests, which, so it was hoped, would discriminate between reliable and unreliable steel, or rather between open-hearth and converter steel. In those days the chief cause of unreliability was believed to be the unequal distribution of carbon in Bessemer steel, and the most effective conditions for excluding this steel were that the material should have a high tenacity, say, 25 tons and upwards; a good elongation, say, above 20 per cent., and the material should show no sign of brittleness after being heated to a bright-red heat and plunged into water of 28° C. or 82° F. By this means the use of the somewhat uncertain Bessemer steel was practically stopped for ship and boiler plates; but in spite of careful testing, iron never having been tested to the same extent, alarming failures were still experienced."

Among these early failures Mr Stromeyer mentions the case of the steel for the boilers of the Russian Imperial yacht Livadia, in which one of the boilers burst while being tested, while others were found to be fractured before testing. The plates of which these boilers were made, although they had stood the workshop practice, broke while the boilers were being taken to pieces. An examination of the material showed carbon 0.09 to 0.20, and phosphorus 0.039 to 0.41, and the peculiar action was supposed to be due to the irregular distribution of the constituents. Other cases are cited in which the plates passed all the tests of the Board of Trade and Lloyds and worked satisfactorily in marine boilers for more than two years, after which time a complete change in the nature of the material appeared to have taken place. This steel, which was made by the Bessemer process, appeared to be sufficiently ductile in the shop, but became brittle in use several years afterwards.

It was soon discovered that an excess of phosphorus was responsible for some cases of brittleness, and this led to a distrust of basic steel for boiler plates, the presence of phosphorus in excess of 0.07 per cent. being considered dangerous. If this were the only point it should be entirely practical to secure satisfactory material by chemical analysis, but analysis alone does not indicate the cause of the change from ductility to brittleness. Mr. Stromeyer refers to the theory that the phosphorus may exist in the steel in two allotropic forms, of which one is harmless and the other brittle. The change from one state to the other during the lapse of time would then account for the behaviour of the material.

"Another cause of brittleness is believed to be improper heat treatment. The general opinion is that this brittleness can be removed by renewed judicious heating, especially if accompanied by hammering or rolling, from which it would follow that the last heating process to which a piece of steel is subjected would have an all-important effect. Others seem to hold that every heat treatment through which a piece of steel passes leaves its mark. According to this view the temperature at which a charge is cast should influence its qualities. This is in a measure confirmed by differences of tenacity of steels of the same chemical composition, but made at different works, and also by the great difference of quality between the purest wrought iron and the purest steels. The former material has never been heated above a welding temperature, the latter has been in a molten condition. If this view is correct then even the temperature of the furnace used for reheating before rolling should affect the quality of the finished article."

In connection with the possible deterioration of boiler-plate material Mr. Stromeyer calls attention to the excellent system of check tests included in the work of the association with which he is connected. This system requires the cutting of test pieces from certain plates as the work of construction progresses, certain of these pieces being reserved for later investigation should any changes develop in the material.

"Engineers have frequently been puzzled by laminations in steel plates which sometimes become visible on planing, and always showed up in samples which are subjected to tension stresses, and are clearly revealed by etching, notably if a solution of from 5 per cent. to 10 per cent. of copper sulphate of ammonia is used. Under the microscope these layers are found to consist of numerous patches of pearlite whose structure indicates an excess of phosphorus. As these layers are generally near the centres of plates they are undoubtedly due to segregation, and one would expect to find the worst cases in those works where very large ingots are cast. Strange to say that is not the case, nearly all the samples in which segregation was detected coming from works in which the ingot moulds were selected to suit the sizes of the plates to be rolled."

While the question of segregation is one frequently discussed, it appears that a high percentage of phosphorus encourages segregation, and at least it appears that the two conditions are generally associated.

"Another class of fractures, which may possibly be influenced by the chemical composition of the material and by improper heat treatment, is excessive and repeated straining, generally called fatigue. Plates which have been flanged round their edges and laid aside sometimes crack when the circumferences have cooled. Thick forgings sometimes crack while being machined, and an armour plate once broke in two, evidently due to a similar cause. These, or somewhat similar results, are produced in boiler end plates and furnace flanges due to excessive heating of the furnace plates, brought about in most cases by grease in the feed, and sometimes by scale. This trouble was not serious as long as boiler presures were low and boiler plates thin and elastic, but the increased pressures demand increased strength, which, if the design is not altered, is accompanied by increased rigidity and liability to fracture."

In considering the failure of boiler flues by cracking, the question of the construction of the flues must be taken into account. Corrugated flues naturally make good provision for elasticity but crackings of the corrugations near the firebars have been not infrequent in Lancashire boilers.

This has suggested the use of plain rings for the furnaces, with corrugated rings inserted at the back ends of the flues.

Mr. Stromeyer gives a tabulated view of a number of experiments upon various corrugated flues, these showing that the elasticity is approximately proportional to the cube of the depth of the corrugations, and the maximum permissible compression proportional to the square of their depths. Taking these facts into account, and assuming the possibility of a difference in temperature of 360 F. between the furnace flue and the shell, which may be the case when deposits of scale of grease are present, it is computed that provision should be made for a contraction of $\frac{7}{16}$ inch, an amount requiring about 12 feet of corrugated flue. Such boilers have been constructed and put into active service, showing no tendency to yield by grooving or cracking after six years' service, under pressure of 180 to 200 pounds.

Mr. Stromeyer makes no mention of the recent theory of M. Hjalmar Braune that brittleness in steel is due to the presence of combined nitrogen, but this view is yet open to confirmation, and it will doubtless be subjected to full investigation.

HEAT INTERCHANGES IN ENGINE CYLINDERS.

CYLINDER CONDENSATION AND RE-EVAPORATION CONSIDERED IN CONNECTION WITH CLEARANCE AND COMPRESSION LOSSES.

Armand Duchesne—Revue de Mécanique.

NEARLY ten years ago Professor Dwelshauvers-Dery announced, as a result of experiments made in the mechanical laboratory of the University of Liége, that he had demonstrated a loss to exist during the compression period in a steam engine cylinder, even when the degree of compression was such as to fill the clearance space completely with steam compressed to initial pressure.

This statement, made in the pages of the *Revue de Mécanique* in 1897, was followed by active and interesting discussions by Boulvin, Hubert, Duchesne, and others in Europe, and by Isherwood in America, the interest arising largely from the fact that it had been hitherto supposed that the statement of Zeuner for the compression of gases held good for steam, and that the injurious action of a given amount of clearance could be neutralized by a proper degree of compression.

A repetition of the experiments, made with varying degrees of clearance and compression, using for the tests the experimental engine in the laboratory at Liége, confirmed the correctness of the observations, and the explanation of the phenomena was found in the action of the cylinder walls. A portion of the heating due to the compression went to heat the walls of the cylinder, the loss being similar to that which occurs when live steam is admitted into a cylinder of a lower temperature than that due to the pressure. Professor Boulvin showed that the true way to reduce cylinder losses was to supply the heat from some other source, such as jacketing or superheating, his conclusion being that: "It is more economical to reheat the walls by live steam than by the work of compression, because this work, being derived through a cycle of low efficiency, involves a large expenditure of heat."

We now have, in a recent issue of the *Revue de Mécanique*, a paper by M. Armand Duchesne, also of the University of Liége, giving the results of a new study of the entire subject, in the light of improved apparatus for determining the temperatures of the cylinder walls.

In the conduct of such investigations it is most important to determine the simultaneous values for the volume, the pressure, and the temperature. The volume at any point in the stroke is given by the dimensions of the engine and the position of the piston; the pressure at any point in the stroke is given by the indicator, but until now it has not been found practicable to record precisely the corresponding temperatures. In these new experiments M. Duchesne has employed an ingenious system of thermo-electric couples, so placed as to give the temperature of the steam, and also the temperature of the cylinder walls at successive points in the stroke, thus enabling the temperature element in the problem to be determined.

The thermo-electric couples are made

with elements of platinum and silver, these having been found to respond very promptly to the rapid temperature changes, and by adjusting the contact to any desired position of the crank the temperature of the cylinder wall or the steam for that point may be read upon the galvanometer. The apparatus has been found capable of responding to within one-tenth of a second, and its use has enabled M. Duchesne to plot temperature curves of much interest and importance. The details of the thermo-electric apparatus are given very fully in the original paper, to which the interested reader is referred. The accuracy of the indications of the thermo-electric indicator is assured, both by a preliminary calibration and by a comparison of its readings with those of the known temperature of the steam at certain points. Thus, the temperature of the steam during the period of admission, if there is no superheating, will be that due to the pressure as shown by the indicator, and this is verified by the reading of the thermometer when set for that portion of the stroke. The thermometers in the cylinder walls are so placed that the thermo-electric junctions are within one millimetre of the inner surface of the cylinder, while those for determining the temperature of the steam are placed in the clearance spaces at the ends of the cylinder. The engine in the laboratory at the University of Liége is constructed with movable heads, in such a manner that the clearance may be varied, and the dead space and the compression are thus under definite control.

M. Duchesne gives a number of valuable thermal diagrams plotted from observations made with this apparatus, showing the action of saturated steam in the cylinder, of jacketing, and of superheating. The heat exchanges between the steam and the metal are shown by the comparative diagrams of the temperatures of the steam and the walls at the same instant and for definite points in the stroke, while indicator diagrams taken simultaneously, give the corresponding pressures, and thus the coincident phenomena are available for study.

Comparing a heat diagram with the theoretical temperatures under the same conditions, M. Duchesne finds some very interesting results. Thus, the temperatures in the cylinder during the periods of admission and expansion, with saturated steam, agree very closely with those corresponding for the successive pressures, according to the steam tables based on the experiments of Regnault.

This agrees with the theory of Hirn that the condensation during the expansion period is deposited in the form of dew upon the cylinder walls. At the beginning of the exhaust there is a difference of but one or two degrees between the temperature of the steam as measured by the thermo-electric couples, and given in the tabular temperature, but as the compression is commenced a tendency for the steam to become superheated is noticed, and at the end of the compression the temperature of the steam is much higher than that of the walls of the cylinder. Thus, for steam at an initial pressure of 5.7 kilogrammes per square centimetre, absolute (81 pounds per square inch) the initial temperature was 156° C., but at the close of the compression the temperature had risen to a maximum of 275° C., dropping again to 156°, at the beginning of the next admission. At this portion of the stroke the movement of the piston is very slight and the rate of compression correspondingly slow, while the temperature of the cylinder walls is only about 130°, or 155° lower than that of the steam. The chilling of the compressed steam by the walls is a function, both of the difference in temperature and of the extent of cooling surface exposed, and all the conditions at the end of the stroke are favorable for a sudden cooling of the steam. The temperature of the steam tends to fall suddenly to that of the cylinder walls, this corresponding to what Professor Dwelshauvers-Dery called the "anticipatory condensation."

Passing now to the temperature changes in the walls themselves, M. Duchesne gives the results of investigations with the apparatus inserted in the metal of the cylinder itself. During the admission the walls have a lower temperature than that of the steam, this being the cause of the initial condensation. In the expansion period the temperature falls, according to a law similar to that for the steam, but less rapidly, the difference in temperature increasing until, at the end of the expansion the steam is about 20 degrees cooler than the cylinder walls.

When the exhaust is opened to the condenser the temperature at first falls, and then rises, this rise apparently beginning after the heat of the walls has evaporated the moisture which has been deposited by the condensation. If there were no compression the temperature of the steam would rise no higher than that of the cylinder walls, but with the beginning of the compression the steam becomes superheated, and the exchange of heat is reversed. The total weight of steam, however, is so small that it produces little or no action upon the temperature of the metal, and if the compression is sufficiently high, and there is no jacket upon the cylinder, a portion of the steam will be condensed.

Actual measurement has thus confirmed the modern view of the action which goes on in a steam cylinder, and this interesting apparatus thus brings to the indicator an adjunct which removes the third element in steam-engine action from the realm of computation, and brings it into the field of direct measurement.

It would be interesting to apply the thermo-electric apparatus of M. Duchesne to the steam turbine, and thus obtain records of the simultaneous temperature changes at various stages of the expansion, an application which will doubtless be made.

SEGREGATION IN STEEL INGOTS.

AN EXAMINATION OF THE NATURE AND CAUSES OF SEGREGATION AND ITS EFFECT ON THE MECHANICAL PROPERTIES OF STEEL.

J. E. Stead—British Association for the Advancement of Science.

WHILE the phenomena of segregation in steel have been studied and discussed by a number of scientific investigators, the general summary of facts and conclusions upon the subject as presented by Mr. Stead at the recent meeting of the British Association for the Advancement of Science gathers the existing mass of information into convenient and condensed form.

Segregation is defined to mean the concentration of the more fusible portions of the steel into local centres, which are the last portions of a molten mass to freeze or solidify upon cooling.

Various researches show that the difference in temperature between the first and last freezing points of a steel depends upon the proportion of carbon present; ranging from 48 degrees for 0.5 carbon to 192 degrees for 2 per cent. carbon.

"According to the rule formulated by Professor Bakhuis Roozeboom, the carbon associated with the iron in the crystallites which first fall out of solution in freezing steel approximates to about 46 per cent. of that in the fluid steel before it begins to solidify. The rule, however, was formulated on the evidence afforded by the freezing of salts; and until the first crystallites of steel can be separated and analyzed, it cannot be regarded as exactly applicable to iron-carbon alloys. Evidence has been obtained by the writer which went far to show and prove that the first crystallites from steel with about 0.37 per cent. carbon, in an exceptional rail, were purer than the rule indicates. The heart of this rail only contained 33 per cent. of what was present in average steel.

"The reason why the pure crystallites do not, under normal conditions, separate out into graduated layers, increasing in carbon with the increasing thickness of the freezing layers, is due to two main causes, viz.:

"*a.* On account of the mechanical entanglement of the mother liquor between the spines of the first crystallites and at the junctions of the complete primary crystals.

"*b.* On account of the carbon diffusing out of the mother substance into the purer first crystallites during and after imprisonment.

"It is only the small residuum of impure mother metal, not mechanically entangled, which eventually escapes and finds its way to the upper central axis of the ingot and constitutes the axial or major segregate.

"Although segregated steel is generally understood to be that in which the impurity is concentrated in the upper central axis, yet steel may contain minor or local segregations in the positions described, as follows:

"*a.* Near the outside envelope, where it exists in the blowholes, etc.

"*b*. In the layers intermediate between the exterior layers and the central axis, either in blowholes or at the junctions of the large primary crystals.

"The structure and the position of the major and minor segregations can be readily detected by etching the complete sections of ingots, bars, rails, etc., after they are polished on No. 1 fine English emery paper. The most rapid results are obtained by immersing the polished steel in a solution of 20 per cent. nitric acid and 80 per cent. water, and keeping it under the liquid until the contrasts of light and dark reach a maximum, when the steel is withdrawn, washed with hot water and afterwards with alcohol and ether. In steels in their natural unhardened condition the parts highest in phosphorus etch out very dark. The study of the structure of steels has led to the most recent knowledge regarding segregation."

Of the various constituents of steel it appears that the sulphur segregates most, phosphorus next, and carbon least of all. Manganese does not segregate with the sulphur, although they appear to combine at or close to the point at which the segregate freezes, provided the manganese is present in sufficient quantity.

"A large part of the segregates in steel ingots is directly traceable to the formation of blowholes in the steel when it is in a pasty condition. The pressure of the evolving gas on the mixture of pure solid and impure liquid in which it forms must squeeze out some of the impure liquid, which, passing inward, ascends to the top of the ingot, or finds its way into previously formed blowholes.

"The gases ascending from the solidifying walls of steel, as suggested by Professor Tetmajer, assist in sweeping the segregate to the top of the ingot; but according to Mr. Talbot's experiment it is shown that the segregated liquid is itself specifically lighter than the purer steel, and that it will ascend independently of the ascending gas. It is probable that the ascending gases induce surface vertical currents and eddies in the steel near to the freezing surfaces, which sweep out the segregating liquid partly imprisoned between the projecting branches of the continually developing crystals."

One method of preventing, or minimizing segregation is the addition of some other element in a minute quantity. For this purpose Talbot has shown aluminum to be effective, while Richards uses silicon to produce a similar effect.

"As both aluminum and silicon make the steel quiet in the mould and more or less completely prevent the evolution of gases and the formation of blowholes in the steel when it is in a pasty condition, it seems certain that if there are no blowholes formed they cannot be the receptacle for segregates, and that, therefore, blowhole segregates become impossible. The pressure of the gas in making blowholes in nonaluminous steel squeezes out the mother substance; but if such pressure is not exerted the mother substance will not be forced out. We must conclude, therefore, that the main reason why aluminum and silicon prevent or retard segregation is because they reduce the evolution of gases."

The practical result of all these investigations naturally is the effect which segregation has upon the strength of the material. Segregation has been charged with being the cause of the premature failure of steel when in practical use, and in fact, we have noted elsewhere in this issue the opinion of Mr. Stromeyer as to its effect upon steel boiler plates. Mr. Stead states that as the result of about 30 years' study of the subject he has arrived at the following conclusions:

"A steel bar or shaft with a brittle core, if subjected to sudden shock, will bend only as far as the internal core is capable of deflection; and if the bending is carried beyond that point, the core will break, and the fracture once started will travel through the steel surrounding it. The bending power of the whole is, therefore, practically that of the core.

"If a segregation core is capable of only limited elongation under static tension, in any but very soft steels its expansion will determine that of the whole section; for when the core gives way the fracture at once travels through the more extensible material surrounding it.

"Similarly, when segregated wire rod is reduced in section by severe drawing through a cold steel plate, the core, or central axis, will break at intervals and the fracture will continue and pass through the

envelope, yielding the well-known cup and cone fracture, but the cone will be truncated and the cups will have irregular bases. When the cones are complete and pointed, overdrawing, and not segregation, is usually the cause of fracture."

Mr. Stead is evidently of opinion that the dangers from segregation have been overestimated. The investigations of Talbot appear to show that at least one-fifth of the structural steel, rails, and similar material is more or less segregated, a proportion far greater than the number of failures.

"According to most reliable evidence, the number of rails which actually break when on the permanent way, in English railroads, averages about 1 in 20,000 per annum. The writer has not found, of those examined, that more than one-sixth of them were axially segregated, and in those which were thus segregated it was doubtful whether they were not initially unsound. The causes, in his experience, which were mainly responsible for failure, were unsoundness, either internally or externally. Indeed his conclusions coincide generally with those of Mr. Job, chemist to the Philadelphia & Reading Railroad, who attributes the greater proportion of the failure of rails to unsoundness resulting from honeycombing and piping, and states that comparatively few failures are due to excessive segregation. Yet it may be accepted as a fact that one in five or six rails in use is segregated. If we accept the suggestion that there is one segregated rail in five on British railroads, and that one in six broken rails is segregated, then only one segregated rail in 60,000 rails per annum breaks, and it is almost certain that in this segregation is not always responsible for failure. It seems, therefore, that although segregation should be avoided it is not nearly such an evil in rails as is maintained by some authorities, unless accompanied by unsoundness. Unsoundness without segregation will equally lead to premature failure. Steel makers are fully alive to the importance of making sound metal, but they know that there is always the liability of producing piped steel when taking precautions to produce soundness."

RAILROADS AND INDUSTRIAL PROGRESS.

A DISCUSSION OF SOME OF THE RELATIONS OF RAILWAY TRANSPORTATION IN THE UNITED STATES TO MINING AND METALLURGY.

James Douglas—School of Mines Quarterly.

IN an address recently delivered before the faculty of applied science at Columbia University, and published in the *School of Mines Quarterly,* Dr. James Douglas gives a most illuminating view of the relations between railroad transportation and the mining industries in the United States.

Dr. Douglas shows that from the very start the United States had to await the coming of the railroad to permit the development of her metallurgical wealth, while Great Britain, by reason of her geographical configuration, and moderate distances, was able to occupy a conspicuous position much earlier. In the United States at first the development of mineral wealth naturally lay near the Atlantic coast and Dr. Douglas shows how it was not until the railroad enabled the iron ores of Michigan and Minnesota to be brought to Pittsburg that the present great development of the iron industry became possible.

"As, however, the west grows—and the west is shifting always to points still further west, its demands for iron grow almost more rapidly than the east, and the center of manufacturing will continue to move westward. This tendency we see in the repid expansion of the only large iron and steel organization west of the Missouri—the Colorado Fuel and Iron Co. While in 1900 its furnaces at Pueblo made only 150,204 tons of pig iron, they made in 1905 407,774 tons. And yet these furnaces depend on long distance freight for their supply of ore. Some of it comes over a haul of 700 miles from southern New Mexico; and much of it comes from Wyoming, and distant points in Colorado. But the fuel supply is near at hand in the Trinidad coal field.

"We know of no iron deposits in the west

comparable in size to those on Lake Superior, but there are many which can be profitably worked. And though within our own territory west of the Great Salt Lake Basin we have no good coking coal, our neighbors to the north can supply it, or we can draw it from New South Wales, which already has shipped coal for railroad purposes to the Pacific Coast. From our other neighbor on the south, should iron and steel works be started on the west coast, we can draw ore from the large deposits said to lie on the very seashore near Acapulco; for distance is being rapidly obliterated by steam, and by it also let us hope international selfishness and commercial exclusiveness. Literature is tending to unify the race and commerce, through the railroad and steamboat, is another beneficent force working to the same end. As people come to know one another better, under a process of natural selection, they will surely imitate and adopt each others better qualities, and without losing their national idiosyncrasies, acquire a higher cosmopolitan character.

"The marvellous feats which two generations of engineers, in handling steam and electricity, has enabled us to perform, may not be duplicated by equal progress during the next half century; but it goes without saying that but for our transportation facilities we would not occupy in the world's race the same advanced position we have acquired to-day, for the very vastness of our country, and the actual distance, from one another and from population of our resources, would have rendered many of them valueless. But, given control of steam, the great size of our mineral deposits and the long distance our continental areas require that we transport material, has inspired our transportation engineers to work on a larger scale than their fellow craftsmen across the sea. We handle longer trains, with larger cars, and as a rule at a much lower rate of freight than they do. Otherwise, neither our miner nor our metallurgist could perform the duty required of them."

Passing from iron the other metallurgical industries, Dr. Douglas shows how transportation and operative methods are necessarily related to each other.

"The interdependence of mines on railroads and of railroads on mines is best appreciated by some familiar examples of what each does. Butte, both the town and the great Butte Mines, are situated on a mountain side facing a valley beneath whose surface water can be reached in any quantity and at all seasons only by wells, but where none flows. The two great corporations operating there have been obliged, therefore, if they were to concentrate mechanically their large tonnage of low grade ore, to transport their ores to water. A site 26 miles distant was selected by the Anaconda Co., and thither to their new Washoe Works are carried daily from Butte, of their own and custom ore, about 9,000 tons at a cost of obout $5.00 per car, or 14 cents per ton. As the ore contains less than three per cent of copper per ton and $1.29 in gold and silver, a haul of that length would be profitable only if carried at such low rates of freight. The other large company, the Boston and Montana Co., sends its ores 170 miles to Great Falls, where, however, the company has the advantage of water power.

"The mining, transportation and smelting operations of our large corporations are on a stupendous scale, but the transportation is as essential an item in the result as the mining and smelting. For the United States Steel Corporation there were handled last year 18,486,556 tons of Lake Superior ore, and they themselves manufacture 12,242,909 tons of coke, which must have used up 20,000,000 tons of coal. This coal production is exclusive of 2,204,950 tons mined by themselves alone. For flux they use 4,000,000 tons of limestone. About 38,000,000 tons of freight, therefore, as ore, fuel and flux, must have been transported, half of it for over an average of 1,000 miles, in addition to 10,000,000 tons of finished product for a shorter distance. A total of about 48,000,000 tons of freight were contributed by this single corporation. As it made only 9,940,799 tons, out of 22,992,380 tons of pig iron made in this country, or 43 per cent. of the whole, the total tonnage moved for a longer or shorter distance by the iron smelting industry must have been approximately one hundred and nine million tons."

In discussing the relation of railway transportation to the great coal industry the

influence of the railroad upon sociological conditions appears. Cheap fuel and cheap transportation together have practically destroyed industrial sectionalism.

"Each great group of states, produces independently its coal requirements and its railroads and industries generally are supplied from its own mines. The Pacific coast and the Southeastern Atlantic coast are most scantly endowed with coal, but on the other hand have abundant petroleum resources, though for metallurgical purposes, the western states sometimes draw coke from other regions. Were it not for this comparatively uniform distribution of fuel, railroad transportation would of necessity be higher, and all interests, especially metallurgical and manufacturing, would suffer. As it is, the old economical divisions into manufacturing New England and northern seaboard states, into the southern cotton growing states, and the western wheat raising states, have disappeared, and with this disappearance has vanished that diversity of interest, involving political dissension, which was so marked and dangerous a feature of national life before the War of Secession. The coal of the southern states has facilitated the introduction of cotton spinning and of other manufactures which give diversity of and a higher grade of employment to the negro population than hoeing corn and picking cotton. Every western state, even those west of the Missouri is becoming a hive of industrial manufacturing life, owing to cheap coal. New England alone, largely due to her distance from coal, is making less comparative progress along these lines than other sections, as she is shut off by tariff partition from her nearest and natural coal supply, that of the maritime provinces of Canada.

"Thus has this great coal industry, to whose development transportation is as much an element as mining become a prominent factor in our national life."

With all this development of natural resources there comes also a warning that those resources, enormous though they are, have their limitations.

"Our anthracite is a rapidly vanishing quantity, and vast as are our bituminous coal fields, they will not last forever. And we are using nature's resources with most wasteful prodigality. We are draining our prolific cow to the last drop—skimming off the cream, and not even making cheese out of the skimmed milk. We are saving only 60 per cent. of our anthracite, burning away the by-product of 90 per cent. of all our coke ovens, and cutting down our vast forests without replanting. In fact, except in the northwest, our timber resources are almost exhausted, and we are borrowing largely from Canada. And from abroad we shall sooner or later have to borrow more than timber. When we reach that stage, we will make less money, which will be far from an evil, for it may oblige us to replace some of our pelf with humility and meekness of spirit. Even today we do not suffer acutely from looking abroad for some of the material of our prosperous manufacturers. We do not make any pig tin—on the contrary, import it from the Malay Peninsula, whence we do not refuse to draw it, though it is made by Chinese labor; and yet our tin plate industry is flourishing. And so, as our resources fail, we shall not lack for raw material as long as the world's supply lasts, for transportation charges by land and water will grow steadily less, and we cannot but believe that many of the selfish barriers which now separate nations commercially will be swept away by the spread of saner notions on political economy, and more unselfish international relations."

This depletion of natural resources must bring with it a more modest pace and a saner frame of mind as the natural wealth of the land becomes exhausted, and some men will have to work harder for less pay.

"But it will not be the mechanical engineer, or the mining engineer, or the chemist, who will suffer; for as we begin to feel the pinch of want and really appreciate that our resources are not illimitable, and that we must stop wasting and use some economy we will be obliged to look to you to save us. By-products have been a by-word among us heretofore. Ere long they will be here as elsewhere the salvation of our industries, and you will be the saviours, for to you the nation will look to maintain the supreme position it has secured. She has attained it by the most energetic use of nature's resources. You must do it by the introduction of economies we now almost despise, and by in-

venting substitutes for material which is now cheap and abundant, but will be ere long scarce and costly. We already see a symptom of the coming change, an unconscious prophecy as it were of future development, in the increasing substitution of concrete, the ingredients of which on the surface of the earth are substantially inexhaustible, for the metals which will soon become rare, and in the generation of heat by the conversion of force instead of exclusively by the combustion of carbon."

INTERNAL-COMBUSTION ENGINES.

A STUDY OF THE INFLUENCE OF THE INJECTION OF A VOLATILE LIQUID INTO THE CYLINDER.

Dr. K. Schreber—Revue Générale des Sciences.

FROM the earliest attempts to make a practical motor in which combustion takes place directly in the working cylinder it was realized that some method must be employed to prevent overheating. So far as the action of the combustion is concerned it is undoubtedly desirable that a high temperature should be maintained, but practical considerations relating to the maintenance of the cylinder, piston, and other working parts demand that some artificial method be employed for keeping the temperature down. In the great majority of gas and other combustion engines today this control of cylinder temperature is obtained by means of a circulation of water in a jacket about the cylinder, although in some small motors, such as are used on automobiles, the cooling is effected by a flow of air.

The obvious method of cooling the cylinder by injecting a spray of water directly into the interior, was employed in the early machines, this having been used in the Lenoir engine as long ago as 1860, and by many others since. The advantages and disadvantages of this method of cooling the cylinder of an internal-combustion engine are discussed very fully in a paper by Dr. K. Schreber, in a recent issue of the *Revue Générale des Sciences,* and some valuable points brought out for practical use.

It is assumed that when a spray of water is injected into a highly heated cylinder the water will be immediately vaporized, this acting to lower the temperature and at the same time convert the heat into mechanical energy, acting through the expansion of the steam upon the piston. While this action does take place, it is found in practice, as Dr. Schreber shows theoretically should be the case, that the efficiency of the engine is lowered by the injection of water, as practised by Lenoir and his imitators. The energy developed by the vaporized water is abstracted from that of the expanding gases, and the total result is inferior to that which would obtain if the water were not used. At the same time the injection of the water has been found effective in protecting the cylinder from becoming overheated, although in practice it is generally used in connection with an external circulation in a water jacket.

During the past few years, however, there has been designed an internal-combustion engine, known as the Banki motor, the invention of Professor Banki, of Budapest, in which the vapor of water is used in the cylinder, and which, apparently contrary to theory, has shown a very high thermal efficiency. Dr. Schreber examines the action of this engine, and shows clearly the reason for its efficiency, and incidentally throws much light upon the action of such motors.

It is well understood that in internal-combustion motors a high degree of preliminary compression is necessary in order that a high efficiency be obtained. The charge drawn into the cylinder must be highly compressed on the return stroke, before ignition takes place, and the higher this compression pressure the better the efficiency.

The ordinary limit to high compression is the temperature of ignition of the explosive or combustible charge. The compression produces heat, and with the usual charges of gas, or hydrocarbon vapor, and air it is easy to reach the ignition temperature by compressions lower than would otherwise be advantageous. The premature ignitions thus produced are objectionable and even dangerous, and cannot be permitted, so that a lower degree of compression is necessarily employed than is desirable. In the case of the Diesel motor the air is compressed alone, so

that there is no limit to the degree of compression by reason of any fear of ignition, the liquid fuel being injected only at the beginning of the stroke, and the heat of compression being used as a means of ignition. In the Banki motor a fine spray of water is injected into the mixed charge of air and hydrocarbon vapor in the suction pipe, and vaporized by the heat of compression, the absorption of heat thus effected enabling a high degree of compression to be used with safety. The economy due to the high compression overbalances the loss produced by the moisture, and the net gain is sufficient to account for the high efficiency of the motor.

Dr. Schreber examines the conditions of operation in the Banki motor, and shows that even with the arrangement there adopted the addition of the water is not effected to the best advantage. Theory indicates that in any case the cooling effect should be produced with the least possible proportion of moisture. With the injection of a water spray into the suction a portion of the water necessarily gathers in the form of drops upon the walls of the cylinder as the piston advances, and these drops are not vaporized until the explosion occurs, when the heat of the combustion and the enhanced temperature of the cylinder walls complete the evaporation. This action, as already mentioned, diminishes the efficiency of the engine, to the same extent as if the water had been injected during the expansion, and to this extent the Banki system is defective.

Dr. Schreber proceeds to discuss the principles upon which water injection may be used to the best advantage. Assuming that the real object of the water is to keep down the compression temperature and thus permit a high degree of compression, it is important that the quantity of water should be kept at a minimum, and that it should all be vaporized during the compression. It is important that the injection should not take place until the temperature of the compression reaches that of the vaporization of the injected liquid at the corresponding pressure. At the end of the stroke there should be a slight excess of temperature in order that the vaporization should be completed, this insuring the absence of any liquid drops to abstract heat from the ensuing combustion. This sequence of events may be regulated by experience, data for computation being as yet uncertain.

Thus far the injection of water alone has been considered, but the idea may be continued further. If, instead of gas, or vapor of hydrocarbon not miscible with water, we use a fuel, such as alcohol, with which water may be mingled in all proportions, it is possible to extend the principle. Dr. Schreber discusses the action of a two-cycle motor, but the principle holds good for either a two-cycle or a four-cycle engine. The charge of pure air is compressed until the compression temperature exceeds that of vaporization of the alcohol fuel, at which moment the alcohol is injected and vaporized together with its contained water. The degree of compression desired may be controlled by the proportion of water, this being kept as low as possible consistent with the prevention of premature ignition.

At the end of the stroke the charge is then ignited in the usual manner, and the cycle is completed. It will be seen that this differs from the Diesel motor in that the liquid fuel, with its contained water, is not ignited by the compression, but merely vaporized, although the action resembles that of Diesel in giving the air a preliminary compression before the fuel is injected. The method appears to eliminate one of the difficulties heretofore existing in alcohol motors, that of the carburetter, since the carburetter is entirely replaced by the vaporizing action of the heat of compression. The degree of compression may not be carried so high as to reach the ignition point of the charge, but it can reach a much higher temperature than would be possible safely if the water were not present.

Dr. Schreber gives an elaborate thermodynamic discussion of an engine operating with a liquid fuel injected during the middle of the compression portion of the cycle, showing that an alcohol motor constructed on this principle should have distinct advantages, and it is to be hoped that such a motor may be given opportunity for practical trial and scientific test. There is no doubt that alcohol may be used with success in the Diesel motor, and the whole field of internal-combustion motor design appears to be open to the fuel which is being liberated by relief from excessive taxation.

CHARACTERISTICS OF STEAM COAL.

AN EXAMINATION OF SOME CHARACTERISTICS OF COAL AS AFFECTING PERFORMANCE WITH STEAM BOILERS.

W. L. Abbott—Western Society of Engineers,

WITH the active interest which is being taken in the study of the nature and fuel value of American coals there has appeared an especial desire to determine the best methods of using fuels of the lower values and costs. In this matter the Western Society of Engineers has taken an active part, some useful papers having been recently presented before it dealing with the subject. Last month we reviewed in these columns the paper of Mr. Bement upon practical methods of testing coals, and now we have one by Mr. W. L. Abbott showing the influence of the fuel upon the performance of a steam boiler, with especial reference to the efficient use of screenings.

"The apparatus employed in the researches to be considered consisted of two Babcock & Wilcox boilers, one being 14 tubes high and 18 wide, of approximately 5,000 square ft. of heating surface, fitted with a chain-grate stoker 75 square ft. in area, which discharged the gases of the fire from under an ignition arch 5 ft. long, immediately among the tubes of the boiler; this boiler was also fitted with a Babcock & Wilcox superheater having an approximate area of 1,000 square ft. The other apparatus employed in one of the series of tests differed only in sizes; its boiler was 12 tubes high and 16 wide, contained 4,000 square ft. of heating surface, was provided with a superheater, and served with a chain-grate stoker 66 square ft. in area.

"The experiments were for the purpose of studying the following features and their influence with the particular apparatus used, and are presented in the following order:—

"Effect on capacity and efficiency due to coal of different sizes. Influence of ash in coal on capacity and efficiency. Effect of variation in size of coal screenings. Results of different thicknesses of fire.

"The experiments consisted in the use of coal separated into various sizes by means of screens having the following square openings: 0.25, 0.50, 0.75, 1.0, and 1.25 inches. The coal was all from one lot, so that the different portions resulting from the screening process were necessarily the "same kind of coal," except that some portions were uniformly larger and others smaller, and that the smallest, on account of its size, was higher in ash."

The tests made with the fuels of these five different sizes were conducted with much care to insure that all conditions, excepting the size, were constant. Plotting the results in the form of diagrams, it appears that the maximum efficiency was obtained with the coal which passed the 0.75 inch screen, this attaining about 70 per cent., the curve at this point being nearly flat, and indicating the efficiency to be nearly constant for sizes from ⅞ to ⅝ inch. The maximum capacity was found with coal of about the same size, this curve being much sharper, however, dropping off rapidly each side of a point indicating about ⅞ inch size.

The percentage of ash in the several sizes showed a marked increase in the proportion of ash in the smaller coal, this being undoubtedly due to the fact that the fine-sized foreign matter separated from the larger coal, or from the roof or floor of the mine, naturally finds its way into the smaller coal. Tests to determine the influence of ash in coal on the efficiency and capacity of a boiler give some very interesting results. If the ash acted merely as a diluent it should affect only the capacity and not the efficiency of the boiler. If, however, its presence offers any obstruction to the combustion process, it is doubly harmful.

The results of the presence of varying quantities of ash are given in diagrams showing the results of tests up to 40 per cent., and both capacity and efficiency are shown to be affected.

"It appears that the useful effect from the fuel drops to zero with 40 per cent. of ash, notwithstanding the fact that the other 60 per cent. of the composition was pure

coal. The fact should be emphasized that although over half of the composition fed to the fire was fuel, it burned without producing any useful effect, for which there are two reasons: one, that on account of obstructed air supply through the fuel bed, incomplete combustion and escaping hydrocarbons carried away a portion of the heat, because the gases passed immediately among the tubes of the boiler. The other is, that owing to the presence of an excess of ash, the percentage of fuel on the rear portion of the grate is greatly reduced. On this account a larger proportion of the air passing through the fuel bed does not combine with the fuel, but enters the furnace as free air. As the prime function of a furnace is to heat the gases passing through it, any increase in the amount of air entering the furnace without a corresponding increase in the amount of fuel burned must result in a lowering of the furnace temperature.

"This lowering of temperature, besides making a long smoky flame which reaches up among the boiler tubes, and is there chilled to below the burning point, also reacts on the fuel bed, reducing the rate of combustion and still further increasing the adulteration of the furnaces gases with free air. When the temperature of the furnace has been thus reduced to about 600 degrees Fahrenheit the boiler is unable to absorb any more heat than is necessary to make up for radiation losses."

The effects of variations in the size of coal screenings also formed a portion of the investigations of Mr. Abbott. Making a diagram for sizes advancing in fractions of an inch by tenths from zero to $\frac{7}{10}$, for the corresponding efficiencies some instructive results were obtained bearing upon the commercial value of the fuel.

"The curves for both efficiency and capacity drop midway between the tests with both small and large coal. This is a peculiarity which may be explained as follows: Performance becomes better as the size of coal increases, until a point is reached when the quantity of large pieces becomes so great that there is not enough fine material to properly close the interstices between, with the result that performance drops off, due to excess of air, until a condition is reached when all the pieces of fuel approach uniformity, when, owing to greater agreement in size, they fit together better, and in a measure produce a homogeneous mass similar to that secured by the fine dust filling the spaces in the fuel bed in the first case.

"The presence of fine dust in excess is a great and important source of trouble. Thus coal through a 0.25 in. square screen produced only 108 h. p., yet a size of fuel which will pass through a 0.25 in. round hole (a smaller aperture than the square opening) will produce as high as 600 h. p. under the same boiler. It is true that the lower ash content of the washed coal has a considerable influence, but this is offset by the larger size of the square screen as against the round one.

"The results are influenced by the thickness of the fire. An excess of air accompanies a thin fire, and because of it, efficiency produced through the boiler is affected. On the other hand, a thick fire reduces the excess of air, but increases the volume of hydrocarbon gases which leaves the surface, or, in other words, makes more smoke. If a furnace is located between the boiler and stoker, these gases will be burned, otherwise they will largely escape among the tubes of the boiler as they did in this case. Therefore, under these conditions, a thin fire increases the loss due to excess of air, but decreases that due to smoke and incomplete combustion. On the other hand, a thick fire reduces the excess of air but increases the smoke and escaping combustible gas, and so the best thickness of fire may be a matter of importance.

"The value of coal screenings is affected by four variables, which are heating power, moisture, ash, and size of the pieces of coal. Heating power of the pure coal—in other words, free from ash and moisture, the real coal—ranges from 13,800 as the minimum to a maximum of 14,500 British thermal units per lb., and moisture from about 9 to 14 per cent. These two characteristics, however, are of minimum importance, as either can affect the result by only a comparatively small amount. With the other two features, amount of ash and size of the pieces, each may exert an influence of such moment that they cause the fuel to be valueless.

INTERURBAN RAILWAY CONSTRUCTION.

ENGINEERING AND COMMERCIAL CONSIDERATIONS INVOLVED IN THE CONSTRUCTION OF ELECTRIC RAILWAYS FOR INTERURBAN TRAFFIC.

Guy Morrison Walker—Electrical Review.

DURING the past ten years the construction of interurban electric railways has grown from the experimental stage to a business covering all parts of the United States. Naturally such a development has had to contend with new problems, and these problems are discussed in a very thorough way in an address delivered at Sibley College, Cornell University, by Mr. Guy Morrison Walker, and published in a recent issue of the *Electrical Review*.

Mr. Walker calls attention to the fact that in such work, as indeed nearly all departments of applied science, there is a constant conflict between diametrically opposing views, those of the engineer and those of the promoter or broker. As he is addressing engineers he naturally endeavors to show the manner in which the engineer may attain the best results from a construction viewpoint, at the same time warning him of the commercial problems which, after all, are the ones which the construction is intended to meet.

"There is a strong disposition on the part of most engineers to spend on the construction of a road all the money that they can get their backers or clients to put up. Even at the present time the most serious handicap upon existing roads and the most serious obstacle to the further development of interurben railways in the heavy construction advised by most engineers and the heavy equipment almost universally recommended by manufacturers.

"The promoters and owners of these properties have not generally taken the public into their confidence, and so it is only those who are on the inside and to whom come the frequent appeals for financial assistance, who know the old, old story of elaborate construction, built at tremendous cost, and heavy equipment run at enormous expense, in advance of the development of traffic. Many of these roads have struggled along borrowing the money with which to pay fixed charges and striving to keep out of the hands of the receiver for a year or two longer, in the hope that by that time the traffic will have developed enough to enable them to pay their way.

"It is impossible to estimate how much the development of interurban railways has been retarded by these false standards of physical perfection, and the time has come when the interest and rights of bankers and investors whose capital has been tied up in unremunerative projects, are entitled to paramount consideration, and I wish to impress upon you that as engineers, you have no more right to experiment at the expense of your clients in an undertaking which they expect to be remunerative, than has a physician to take liberties with the body of his patient."

Mr. Walker emphasises the interest which the engineer has in the ultimate commercial success of his work, and strives to impress upon the young engineer the importance to himself that his clients should profit by his work. Not only is his professional reputation involved, but future business often depends upon previous success, and the large fee will be cheerfully paid from a successful enterprise when a pittance will be grudged from a wreck.

"In considering a new proposition you should first determine what investment the territory will support. Be assured that the necessary capital is in sight and then plan a completed and earning plant to come within the limits of the proposed investment. It is one of the most common complaints against engineers that the completion of their plans usually costs fifty per cent more than their estimates. As a rule there is nothing so worthless as the engineers' report, which the promoters lay before bankers and financiers, unless it be the franchises of which they talk so glibly and for which they claim to have expended such large sums. After the surveys necessary to locate the line, which should not cost much, the first expenditure of money should be for the securing of all the right of way that can be secured without con-

demnation proceedings, and then suit should be at once instituted against these. The reason for this is, that if an enterprise has any merit in it whatever, its success is assured from the time that it owns a continuous strip of right of way between the proposed terminals, while if it has no merit there is no expenditure that involves less loss, for the fact is that the importance of transportation is so great that there are few real estate holdings that appreciate in value as do these comparatively worthless small tracts when strung together in a continuous line from city to city."

After the right of way comes the actual construction work, including grading, track, and power house. Mr. Walker lays stress upon the making of a good showing in the matter of pushing the work ahead to the completion of a continuous line between the terminals, even if the work may not be of the most solid and massive character at the first. A portion of the line, no matter how well built, is ineffective compared with a completed job which may be subject to improvement with the demands of traffic, and the encouragement to investors from such a showing is always marked.

Again, it is a mistake to instal a power house large enough for all possible extensions and requirements, instead of waiting until the success of the immediate line is assured. It is the mileage which earns the money, and it is undesirable to burden a small proposition with the capital charge of a larger power house than is really needed.

"The proper plan is to instal units, second hand, if possible, no larger than the existing mileage needs for its operation, installing additional units as fast as its growth and extension may make necessary, until the territory has been reasonably covered, and the traffic developed to the point where the mileage can properly use and the earnings carry the cost of a suitable power-house, for when this time comes, the original units are not loss, but may be reinstalled in other places to carry other plants through a similar period of development. There is no other initial economy that pays as this does, for it is rarely possible to anticipate the power demands of a territory, and great loss has been incurred by attempting to do so.

"One of the most foolish extravagances is the building of a double-track road where a single track will carry all the traffic that can be developed for years to come, for, with your right of way and grade, it is a simple matter to supply the second track when the traffic becomes too heavy for the first. So, if you really must have fifty miles of track, and the distance is only twenty-five miles, find some other place to build the other twenty-five miles, for it is far better to have two single-track roads paying big dividends than a fine double-track proposition that does not earn its fixed charges."

The question of equipment is discussed very fully by Mr. Walker, and here again he warns the engineer about burdening a new enterprise with too heavy a charge. The estimating of probable traffic is a matter in which the inexperienced engineer is apt to make serious mistakes, and this subject should form matter for distinct and careful study.

"In estimating the traffic from a proposed interurban road, you will find it unsafe to consider the population of your larger terminus. This larger terminus is extremely necessary for the success of such a road, for you must have some place to which the people along the line desire to go, but you will find that the people of the larger cities have little business and no inclination to leave their large city and ride out to the smaller points along the line, so you must begin by ignoring the population in the large city. You will also find that the much-talked-of farmer traffic is so small as to be almost a negligible quantity. The riding population, which must be the source of your earnings, you will find to be the population of the villages and towns that you reach, who seek the large terminal for business or pleasure.

"For the proper support of an interurban railroad this urban population, outside of the large terminus, should not be less than 750 per mile, and you will find that such a population will yield about five dollars per capita. Such a population will support an electric railway as ordinarily built, paying ordinary fixed charges on a bonded debt, large enough to cover the cost of its construction, but without profit to the promoters or stockholders. In order to be

profitable, such a line should have an interurban population, outside of the larger terminus, of at least ten hundred per mile of track. Should this population, however, be less than 750 per mile of track, the proposition is likely to prove a failure unless built with extraordinary economy.

"It is hard to discuss the cost of construction of interurban roads, because so few of them are built with real money. There is so much waste in the methods of the ordinary promoter, and his ways of raising capital are not only expensive, but his lack of credit makes the carrying charges during the period of construction extremely high. If built and paid for with real money these roads should vary in cost from $16,000 to $25,000 per mile, according to cost of right of way, weight of rail, and power and equipment used. In no case should they exceed this higher sum unless there exists in the particular place some physical difficulties, such as a large amount of tunneling, rock cuts, or heavy bridging.

"On the other hand, I have known one or two very profitable propositions doing good service in small communities that have been built for less than $15,000 per mile, these sums including in all cases the cost of power-house and equipment."

ELECTRIC CANAL TRACTION.

PRACTICAL EXPERIENCE WITH MECHANICAL AND ELECTRICAL TRACTION ON THE TELTOW CANAL.

Erich Block—Elektrotechnische Zeitschrift.

WITH the development of internal waterways in competition with railway transport there has naturally come a disposition to substitute mechanical for animal traction, and many attempts have been made to devise some system which should be commercially acceptable.

Since the chief advantage of canal transport lies in its low cost, any system of traction, to be successful, must be cheap, and it is this fact which has prevented many of the otherwise satisfactory plans from coming into use. The latest development of canal traction to attract attention is the electrical system introduced on the completed portion of the Teltow canal, a portion of the great system intended ultimately to connect the Oder and the Elbe, and from an account of this work by Herr Erich Block, the government constructor of the works, published in recent issues of the *Elektrotechnische Zeitschrift*, we abstract some of the features of interest relating to the undertaking.

The portion of the work now known as the Teltow canal represents the section of the larger waterway extending from the Oder to the Spree, passing through the province of Teltow, a suburb of Berlin. The canal prism is 2.5 metres deep, 20 metres wide at the bottom, and 30 metres wide at the surface, including in its course some small lakes in the vicinity of Berlin, and serving as a drainage channel for the marshy district near Machnow. The canal is intended to permit two barges of 600 tons capacity to pass each other readily, and as the route passes through an active industrial district there are numerous bridges spanning the channel, and various manufacturing sites along the banks. Tow-paths are provided on both sides, and the banks are well protected against the action of waves which may be produced by the barges and tow-boats, while harbors have been arranged at numerous points to enable merchandise to be handled without interfering with transport. There is but one lock in this portion of the canal, with a lift of about 3 metres, this varying slightly according to the state of the water levels in the Spree and the Havel. The lock gates and mechanism are arranged to be operated by electric motors, this enabling the time for the passage of the boats through the lock to be greatly expedited.

In considering the choice of traction method the success which had been attained several years ago on a smaller scale with electric traction on the Finow canal and on the Douai canal by the Siemens & Halske system attracted attention, and it was determined to adopt a similar plan for the present undertaking. In pursuance of this decision it was settled that no other method of towing should be permitted, since the

economical success of the plan would be undoubtedly impaired by the unavoidable interference of more than one system.

The plan as finally adopted on the Teltow canal includes the construction of a light railway of 1 metre gauge on each tow-path, on which electric locomotives or tractors are run, the current being taken from overhead wires by pole-collectors of the sliding-bow type. The locomotives, of about 4 tons weight, are fitted with a series-wound motor of 8 horse power, for traction, a 3 horse-power motor for manipulating the towing mast, and another 3 horse-power motor connected to a drum upon which the tow-rope may be wound.

Since the pull on the tow-rope tends to overturn the locomotive, on account of the oblique position of the rope, the weight upon the locomotive is so distributed as to cause the greater portion of the load to fall upon the land side of the track. The towing mast can be raised or lowered by its own motor, under full control of the driver, so that the rope may clear any obstructions, or pass under bridges, the normal position being as low as practicable in order to minimize the tendency to tilt to locomotive.

The tow-rope, a steel cable 10 mm. in diameter, passes through a collor on the end of the mast, and is attached to a drum, which, as already stated, has its own electric motor, attached, not directly, but through the medium of a sliding friction clutch. The friction of the clutch is somewhat in excess of the normal traction pull, so that provision is made against any sudden shock or resistance, while the clutch may also be released and the locomotive permitted to run ahead the entire length of the cable, and wind up the load again at the will of the driver. In connection with the operation of these locomotives Herr Block remarks that while it is possible that machines of a somewhat higher efficiency might possibly have been designed, it must be remembered that the cost of the electrical energy forms only about one-eighth of the total cost of traction, so that there is not room for much gain in economy by increasing the efficiency of the locomotives.

Since there are two lake sections on the canal it has been found necessary to provide tow-boats to haul the barges over those portions of the route. Experiments were made with tow-boats propelled by gasoline motors, and by suction-gas engines, but these not proving satisfactory, trials were given to electrically-propelled boats, using accumulators, and taking current from overhead conductors. The latter method proved by far the most desirable from an economical point of view, although the tow-boat was soon demonstrated to be far less efficient than the traction locomotive, the current consumption being about three times as great for the boat as for the locomotive. The boats in use are equipped with accumulators, as well as with overhead connections, the latter being of two types, the ordinary trolley pole and the Lombard-Gérin collector, this latter apparatus being similar to that used in the so-called trackless trolley. A small motor is arranged in a trolley carriage running on the overhead wire, the motor being driven from a three-phase generator on the boat, propelling the collector ahead of the boat at the same speed as the vessel itself. With the ordinary trolley poles there is some difficulty in maintaining contact, and with the Lombard-Gérin collector the speed control does not always work satisfactorily, so that the accumulators form a desirable auxiliary.

In order to insure the economy in operation which is essential to successful mechanical traction for canal service, the electric generating station was designed to supply the current at the lowest practicable rate, and hence the generating station was designed to produce an excess of current for power supply to manufacturing establishments as well as to the canal service. In order to retain full control, the plan adopted was to supply current to the canal and to the municipality, the latter alone disposing of the power to the industrial establishments. With an average traffic of two million tons per year the canal service is estimated to require about 500 horse power, while the power station is designed for 2,300 horse power, divided into two turbine units of 1,000 horse power each, and one reciprocating-engine unit of 300 horse power. The turbines are of the Zoelly type, and the reciprocating engine is a horizontal tandem machine. Each steam set is connected to two dynamos, one delivering three-phase current at 6,000 volts and the other continuous current at 600 volts, the latter cur-

rent being for the towing near the station and the former for transmission and conversion for the more distant points.

The principal element in the success of such an equipment as that installed on the Teltow canal is the possibility of keeping the cost of traction down to a point where it can compare with animal haulage, and compete with railway transport. The experience already obtained is hardly sufficient to enable reliable comparisons to be made, but it is apparent that such a system demands a heavy traffic for its permanent success. The indications are that for an annual traffic of 2,000,000 tons, electric haulage costs about as much as the use of steam tow-boats. For heavier service the advantage is in favor of the electricity, being about 80 per cent. of the steam cost for a traffic of 4,000,000 tons. These results are based on loads of 1,200 tons, or two 600-ton barges for each locomotive, as the system is now operated.

The operation of the Teltow canal will be watched with the greatest interest, both in Germany, where the manner of the development of the whole system of internal waterways, and in other countries, in which the entire subject is involved in the matter of efficient mechanical traction.

THE COST OF POWER.

A REVIEW OF THE INDUSTRIAL POWER PROBLEM IN GREAT BRITAIN WITH REFERENCE TO COMMERCIAL EFFICIENCY.

W. B. Esson—Civil and Mechanical Engineers' Society.

IN a presidental address recently delivered before the Civil and Mechanical Engineers' Society by Mr. W. B. Esson, the industrial power problem, in its relations to commercial efficiency, is discussed in a manner which demands attention and review. Mr. Esson considers the cost of the generation and distribution of power with regard to conditions obtaining in Great Britain, with a view of determining the best source of power for a central station, as compared with the costs in an isolated plant, the whole question being broadly reviewed, while actual costs are carefully worked out.

Taking steam, gas, or oil engines as available for the purpose, and assuming a single unit of 500 brake horse power, or about 470 electrical horse power as a size comparable with that of an isolated plant, running for 2,800 hours per year, the electrical output figures out about 1,000,000 electrical horse-power hours yearly.

"A triple expansion steam engine of the size mentioned running condensing at 300 revs. per min. with 150 lb. pressure, and, say, 100 deg. superheat, will require no more than 14 lb. of steam per electrical horse-power per hour at full load, of 16 lb. at half load, or working non-condensing 20 lb. and 24 lb. respectively. As a general rule from 20 to 30 per cent. of the heat in the fuel cannot be utilised as it passes up the chimney in the waste gases, and is dissipated by radiation from the furnaces and flues. Accordingly, from 70 to 80 per cent. only of the heat in the fuel reaches the water, though it is claimed that with water-tube boilers, economiser, chain grate stokers and superheaters as much as 85 per cent. of the thermal units in a high-class coal has been returned in steam. As in different types of engine the disparity between the fuel consumption at full and reduced load is not the same, we will take in all cases the mean consumption between full load and half load, and there is no doubt that under this assumption, with the power producing plant carefully designed throughout, we can easily get when working condensing and with superheat an electrical horse-power-hour for every 2.25 lb. of bituminous slack consumed in the furnaces. This makes ample allowance for the steam used in the auxiliary plant and for the coal used in lighting up, etc. As this class of fuel can be obtained in the manufacturing districts at a cost of 7s. 6d. per ton delivered in the boiler house, or about 25 lb. for 1d., it will be seen that for steam plant the cost of an electrical horse-power, so far as the fuel is concerned, works out at 0.09d. per hour.

"Let us see now what we can do with a gas engine using producer gas. In the early forms of producer for making power

gas only anthracite coal or coke could be used, both of which consist almost wholly of pure carbon. For suction gas these are still the only fuels which can be employed, and, needless to say, they are very expensive as compared with bituminous slack. But the problem of using this latter fuel for power gas manufacture has been completely solved in the Mond producer. When working this system on a large scale it pays to recover the ammonia which is washed out of the gas before it is suitable for burning in engines."

Taking anthracite for use in the gas producer, using the suction producer system, and a consumption of 1 pound of coal per horse power, with coal at 24s. per ton, the cost works out about 0.129d. per horse power per hour. With slack, used in the Mond producer, the fuel costing 7s. 6d. per ton, the cost is materially lower, reaching 0.051d., this not taking into account the recovery of ammonia.

Recognizing the superior efficiency of the Diesel motor, Mr. Esson uses this in computing the cost of power from oil, and taking the cost of suitable oil in London as 45s. per ton, with a consumption of 0.52 pound per electrical horse power per hour, the power cost becomes 0.126.

"The Mond gas plant, on the assumptions made as regards the cost of fuel per ton, easily distances its competitors in economy. The figures are:—

Mond gas	0.051d.	per E.H.P.	per hour.
Suction gas	0.129d.	"	"
Steam (condensing)	0.090d.	"	"
Steam (non-condensing)	0.120d.	"	"
Oil	0.125d.	"	"

Taking into consideration with the above figures the installation costs at the works, and allowing 10 per cent. for interest and depreciation, the total costs per electrical horse power per hour is given as follows:

Mond gas	0.387d.
Suction gas	0.423d.
Steam (condensing)	0.385d.
Steam (non-condensing)	0.402d.
Oil (Diesel motor)	0.444d.

These figures are for an isolated plant of 500 horse power, and the power costs are those which may well be compared with those of general power-supply stations.

"Let us consider the circumstances affecting supply of power from a general power house, premising at the outset that electricity furnishes the only means by which such distribution can be successfully carried out. The price at which the power can be profitably sold is, of course, influenced very largely by the expenditure on the power-producing plant. The difference between the cost of generation and distribution and the amount paid by the customers for power constitutes the gross profit on the undertaking, and if the business is to be profitable this must be sufficient to pay administration charges and interest on capital, while making ample contribution to a depreciation fund. It is manifest that, other things being equal, the less the outlay per horse-power the less need be the difference between the prime cost and the cost to customers, and the cheaper, therefore, will be the supply.

"The amount which should be set aside to meet renewals—or, in other words, to form a depreciation fund—has been a matter of some controversy. We will take it that 2½ per cent. on the capital outlay represents a fair annual contribution to depreciation, and it will be assumed that, when the undertaking has reached its ultimate capacity, there is the same amount of share and loan capital. Calculating on a dividend to shareholders of 10 per cent. per annum, and on interest to debenture holders at 5 per cent., this amounts to paying on the whole capital interest at the rate of 7½ per cent., and with 2½ per cent. for depreciation the annual obligation in respect of capital amounts to 10 per cent. As a rule shareholders do not get 10 per cent. But an estimate giving scope to the consulting engineers' imagination is found to be very useful for getting money in. The number of incidents which occur to prevent prospective dividends from being realised is perfectly appalling, and if the price to be charged to the power users is fixed at such a figure as will return a prospective 10 per cent. to cover interest and depreciation, I am sure it will be found none too high in the end.

"The percentage charges in respect of capital being taken as above, the amount actually assignable to each horse-power-hour depends, of course, upon the amount

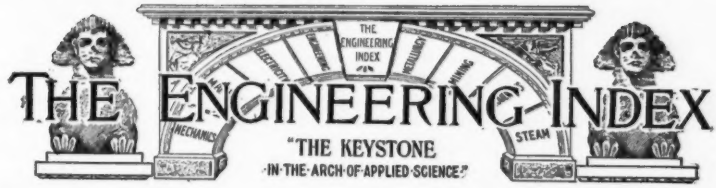
of capital invested and on the number of horse-power-hours sold. The expenditure on each horse-power of plant capacity depends upon many conditions. Beginning with the site on which the works are erected, the difference between land values in different localities is enormous. The next thing influencing capital expenditure is the cost of the buildings in which the power generating plant is housed. The last and most important factor influencing the outlay is the cost of the generating machinery and equipment. If steam turbines are used the cost per horse power installed is less for large generating sets than for small ones, and the capital cost with regard to plant capacity is correspondingly reduced. In addition to the saving on the sets themselves, as these become larger the cost per horse-power in foundations, steam pipes, switching gear, and all that appertains to the generating plant goes down. Working on a large scale makes large sets possible, and as these take up much less space for the power installed, the buildings can be made relatively smaller and the capital cost reduced all around. With respect to fuel economy, with increase in size the steam used per horse-power per hour diminishes, and at partial load large sets may actually use less steam for the same power than smaller sets running at full load. There is also economy in labor, as large sets require no more attention in running than small ones."

Mr. Esson goes into a detailed review of the actual cost of power in a number of electricity-supply works in London, as well as in the provinces, as a consequence of which he concludes that the cost for generating and distributing current, for a plant of 20,000 horse power, cannot be brought below about 5/8d. per horse power per hour, assuming interest charges at 4 per cent., and dividends at 6 per cent.

"Several of the London undertakings supply power at 3/4d. per electrical horse-power-hour, and seeing that the total cost of production, excluding capital charges, amounts to something over 1d., it is only natural to wonder how it is done. Well, it is just because they are not power undertakings that they can supply power so cheaply, just because a large portion of the output is sold at a comparatively high price for lighting can the power portion be supplied at a price which carries no administration or capital charges. Dumping units to fill in the valleys in the load curves is a good thing but when, owing to the loads overlapping, the generators must be set aside to supply power or lighting, but not both, obviously lighting pays better. At 4d. per unit for lighting and 1d. for power, the machinery, to produce the same revenue, must, when supplying power, run four times as many hours as when supplying light. To produce that revenue nearly four times the amount of coal and oil is consumed, to say nothing of extra wear and tear, all of which goes to show that for a purely power undertaking to be successful it must be conceived on a scale such that the capital cost per horse-power is as low as possible, and the running charges are brought down to the irreducible minimum.

"Though our figures show that it will pay the large consumer better to use home-made power than to purchase companies' power, there are thousands of small consumers to whom a cheap supply from the companies must prove an inestimable boon.

"Though it may pay to generate the power on site, considered from the purely investment point of view, the margin is not large, and if the companies can come within reasonable distance of the price I have mentioned they will be sure to secure a goodly number of large consumers. The reason is that, to compete with the power companies, the equipment in the factory must be of the highest efficiency, and to get up-to-date equipment the power user would have to spend money. That, needless to say, is precisely what he doesn't want to do, and often he hasn't the money lying by to spend. As a rule, a manufacturer will do anything rather than put down hard cash to improve his plant, and the companies, knowing this, must be ready to put it down for him. He may know that his power plant is old and inefficient, that years ago it should have been thrown on the scrap heap, and yet he will hesitate. Trade may be uncertain, times may be bad, and he feels that when money is spent on new plant it is irrevocably sunk whether trade revives or not.



The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article.
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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BRIDGES.

Arch.

New Masonry Bridge over the Loire (Nouveau Pont en Maçonnerie sur la Loire). A. Dumas. Illustrated description of new highway bridge with seven arches of 48 metres span each. Details of centering and construction are given. 4000 w. 1 plate. Génie Civil—Sept. 29, 1906. No. 79911 D.

Cantilever.

The Long Lake Highway Bridge. Describing the design and erection of a steel cantilever highway bridge of 525 feet span across Long Lake, N. Y. Structural details and strain sheets are given. 2000 w. Eng Rec—Sept. 29, 1906. No. 79558.

Concrete.

Double-Track and Four-Track Concrete Bridges on the Philadelphia & Reading R. R. Lines. Illustrated detailed description of the construction work of two large concrete bridges. 3500 w. Eng Rec—Oct. 13, 1906. No. 79780.

We supply copies of these articles. See page 479.

Hungary.

The Bridge over the March at Hradisch (Die Marchbrücke in Ungarisch-Hradisch). A. Hawranek. A detailed account of the braced arch of 76.8 metres span with strain sheets and structural data. Three articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 28, Oct. 5, 12, 1906. No. 79933, each D.

Nile.

The Nile Bridge at Cairo. Photographs and progress diagrams with an account of the work so far as executed. 2000 w. Engng—Oct. 12, 1906. No. 80055 A.

Reconstruction.

Reconstructing the Piers of a Double-Track Railroad Bridge. An illustrated article explaining the conditions and describing work at Schenectady, N. Y. 1400 w. Eng Rec—Oct. 6, 1906. No. 79671.

Rhine.

The New Bridge Over the Rhine at Basle. E. C. Morel. Illustrated description of a beautiful stone bridge of seven spans, and its construction. 2500 w. Archts & Buildrs Mag—Oct., 1906. No. 79736 C.

Suspension.

Cost of Erecting the Brooklyn Towers and End Spans of the Williamsburg Bridge, New York City. Francis L. Pruyn. Describes the work and gives a detailed estimate of the cost. Ills. 2500 w. Engng-Con—Oct. 24, 1906. No. 80149.

Swing Bridge.

New Swing Bridge at Velsen. Illustrated detailed description of a large electrically worked swing bridge over the North Sea Canal in Holland. 1600 w. Engr, Lond—Oct. 19, 1906. No. 80144 A.

Viaducts.

A Steel Viaduct with Concrete Casing and Floor. Illustrates and describes a six span viaduct for foot passengers being erected across railway tracks at Cedar Rapids, Ia. 600 w. Eng News—Oct. 11, 1906. No. 79719.

Concrete Viaducts on the Key West Extension of the Florida East Coast Ry. George P. Carver. An illustrated article showing the design employed for about 500 reinforced concrete arches from 45 to 60 feet span, and describing the construction work. 2500 w. Eng Rec—Oct. 20, 1906. No. 79882.

CONSTRUCTION.

Caisson.

A Reinforced Concrete Tunnel Caisson. Illustrated description of interesting and unusual work being carried out by the Hudson Companies in connection with the tunnel construction which will connect Manhattan and New Jersey. 4500 w. Eng Rec—Sept. 29, 1906. Serial. 1st part. No. 79553.

Concrete.

Concrete in Factory Construction. E. A. Trego. Illustrates and describes examples of modern factories, with a general review of the principles of construction. 5000 w. Cement Age—Oct., 1906. No. 79859.

Speed in the Erection of Concrete Buildings. J. G. Ellendt. A report of recent building for the Yale & Towne Manufacturing Co., of Stamford, Conn. Ills. 800 w. Cement Age—Oct., 1906. No. 79862.

Contracts.

Different Plans of Letting Contracts. Frank B. Gilbreth. From a paper presented before the Am. Pub. Works Assn. Describes briefly what is known as the "Lump Sum" contract, and the "Percentage" contract, and gives details of the "Cost-Plus-a-Fixed-Sum" contract. 2200 w. Eng News—Oct. 18, 1906. No. 79835.

Culverts.

Concrete Tile Culverts in Ontario. Information from the report of A. W. Campbell relating to the extensive use of concrete tile for small highway culverts, considering points in their construction. 1800 w. Eng Rec—Oct. 13, 1906. No. 79782.

Dams.

Recent Practice in Hydraulic-Fill Dam Construction. James D. Schuyler. An account of the writer's experience in this class of construction with facts from the experience of others. This process cheapens the cost of handling and compacting earth, making it feasible to increase the bulk of any dam without unreasonable cost. Ills. 18600 w. Pro Am Soc of Civ Engrs—Oct., 1906. No. 80100 E.

The New Croton Dam. Edward Wegmann. An illustrated review of this important engineering work. 5000 w. Eng News—Oct. 14, 1906. No. 79618.

The Wachusett Dam. Illustrates and describes this dam of the Metropolitan Water Works, recently completed at Clinton, Mass. 900 w. Eng Rec—Oct. 6, 1906. No. 79669.

Floors.

Reconstruction of the Floors in the Equitable Building, Baltimore, Md. Corydon T. Purdy. Illustrates and describes the terra cotta arch construction adopted for rebuilding these floors after the fire. 900 w. Br Build—Sept., 1906. No. 79715 D.

Vibrations of Concrete Floors. E. P. Goodrich. Remarks on the advantages of reinforced concrete in places subject to earthquakes, giving illustrations from San Francisco. 1000 w. Cement Age—Oct., 1906. No. 79861.

Grouting.

Grouting a Leaky Tunnel on the Paris, Lyons and Mediterranean Ry. Describes

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repairs to the Limonest tunnel. The method adopted was to pump cement grout through holes in the arch. Ills. 1200 w. Eng News—Oct. 11, 1906. No. 79720.

Highways.

Highway Construction. James Owen. Read before the Am. Soc. of Munic. Imp. Discusses the fundamental factors in road construction, and the application of tar to overcome the dust trouble. 4000 w. Eng Rec—Oct. 27, 1906. No. 80109.

Oil Tar as a Dust Layer and Weed Destroyer. George H. Waring. An account of the use, with success, of this product for road betterment. General discussion. 4500 w. Progressive Age—Oct. 15, 1906. No. 79760.

Office Building.

The Trust Company of America Building. Illustration of a new building of 25 stories above street level, being erected in Wall St., New York City, and a description of interesting construction methods. 4000 w. Eng Rec—Oct. 20, 1906. Serial. 1st part. No. 79887.

Reinforced Concrete.

Reinforced Concrete Buildings for a Paper Mill. Illustrates and describes a group of large buildings recently completed at Bogota, N. J. 2500 w. Eng Rec—Oct. 27, 1906. No. 80110.

Reinforced Concrete Construction. Walter Mueller. Presents its advantages as a structural material for factories, with illustrated description of reinforcing systems. 5500 w. Cement Age—Oct., 1906. No. 79860.

The Coignet Reinforced-Concrete System. Information concerning the methods used by this French engineer. 2000 w. Am Archt—Sept. 29, 1906. No. 79538.

The Design of Continuous Beams in Reinforced Concrete. John Stephen Sewell. A statement of the writer's opinion, and the reasons for it. 1500 w. Eng News—Oct. 25, 1906. No. 80091.

Retaining Walls.

The Design of Reinforced Concrete Retaining Walls. Edward Godfrey. Treats of a wall to retain ordinary fill or prevent natural earth from slipping. Diagrams. 3000 w. Eng News—Oct. 18, 1906. No. 79831.

Roofs.

Ferroinclave Roof Construction. Alexander E. Brown. An account of the circumstances that led to the design of this type of roof, giving tabulated tests made of the material. Ills. 2400 w. Pro Am Soc of Mech Engrs—Oct., 1906. No. 79857.

Saw-Tooth Skylight in Factory Roof Construction. Fred S. Hinds. Illustrates and describes the construction methods. 2500 w. Pro Am Soc of Mech Engrs—Oct., 1906. No. 79858.

The Development of Iron and Steel Roof Design. Reviews the history of iron roof construction briefly and discusses the Charing Cross Station roof, and other examples. 3000 w. Builder—Sept. 22, 1906. Serial. 1st part. No. 79572 A.

Tunnels.

Grade Rectification in the Battery Tunnel, New York. Describes the work of rebuilding the imperfect portions of the East River tunnel of the New York Rapid Transit Railway. Ills. 1500 w. Eng Rec—Sept. 29, 1906. No. 79555.

The Completion of the Northern Section of the Karawanka Tunnel (Der Vollausbruch beim Baue des Karawankentunnels, Nord). Jos. Fischer. Illustrating and describing the method of enlarging the original small bore to the full section for the completed tunnel. 3000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Sept. 29, 1906. No. 79980 D.

The Double-Bore Method of Tunnelling (Die Zweitunnel Baumethode). Karl Brandau. A discussion of the advantages of boring two separate tunnels instead of a single large bore, with illustrations from the work on the Simplon tunnel. 2500 w. Schweiz Bauzeitung—Sept. 22, 1906. No. 79972 B.

MATERIALS OF CONSTRUCTION.

Brickwork.

The Strength Properties of Brickwork as Determined by Experiment. W. C. Popplewell. Read before the British Assn. of San. Engrs. A report of tests made and their results. 2800 w. Munic Engng—Oct., 1906. No. 79734 C.

Cement.

Machinery and Processes for a Portland-Cement Plant. F. H. Lewis. The second paper treats of the machinery and processes for grinding by separation, with numerous illustrations of plants and apparatus. 3000 w. Engineering Magazine—Nov., 1906. No. 79995 B.

Recent Progress in the Cement, Lime, Phosphate, and Soda Industry (Neuere Fortschritte in der Zement, Kalk, Phosphat, und Kali industrie). C. Naske. Discussing especially modern grinding and mixing machinery as applied to the manufacture of cement and allied industries. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 29, Oct. 13, 1906. No. 79904, each D.

Some Experiments on the Permeability of Cement-Mortars to Water Under Pressure. Joseph W. Ellms. A report of a series of experiments made by the writer, with a study of the results. 2000 w. Eng Rec—Oct. 27, 1906. No. 80112.

Stone Crushing.

A Large Stone Crushing Plant at Gary, Ill. Illustrates and describes the plant and its interesting machinery equipment.

We supply copies of these articles. See page 479.

800 w. Eng News—Oct. 11, 1906. No. 79716.

Structural Steel.

The Deterioration of Structural Steel by Corrosion and Electrolysis. Selection from a paper read by James B. Cook, before the Memphis Engineering Society. Discusses the action of rust and its results, electrolysis and its action, and the danger of stray currents on iron and steel skeleton construction. Ills. 3000 w. Archts & Build's Mag—Oct., 1906. No. 79737 C.

MEASUREMENT.

Current Meter.

The Ott Current Meter of the Swiss National Hydrometric Bureau (Die Ott'schen Flügel des Eidgenössischen Hydrometrischen Bureaus). An illustration of the standard propeller meter as used for measuring the flow of water in streams; full details are given as shown at the Milan exposition. 3000 w. Schweiz Bauzeitung—Oct. 6, 1906. Serial. Part 1. No. 79975 B.

Geodesy.

The Curvature of the Geoid in the Simplon Tunnel (Les Courbures du Geoide dans le Tunnel du Simplon). Marcel Brillouin. Data of observations in the Simplon tunnel showing the influence of external influences upon the measurements. 1200 w. Comptes Rendus —Sept. 10, 1906. No. 79915 D.

Horizometer.

The Horizometer. Bradley A. Fiske. Describes an instrument by which the distance of an object at sea can be measured by measuring the angle of depression of its water-line below a horizontal line, drawn from the eye of the observer. Ills. 4000 w. Pro U S Nav Inst—Sept., 1906. No. 79846 F.

Surveying.

Azimuth, Latitude and Time from Polaris, and a Southern Star, with Surveyor's Transit. George O. James. Explains a rapid and convenient method which gives a very good approximation of the azimuth of the Pole Star at the instant of bisection. 1500 w. Jour Assn of Engng Soc's—Aug., 1906. No. 79892 C.

The Northern Boundary of Massachusetts. Nelson Spofford. Gives briefly the history of the New Hampshire boundary and the controversy with Massachusetts, the old methods of surveying, the re-surveys in 1825 and in 1885, and the Vermont boundary. Also a statement by Frank W. Hodgdon on the way the line has been established. 7800 w. Jour Assn of Engng Socs—July, 1906. No. 79725 C.

Testing.

The New Hydraulic and Cement Testing Laboratories at the University of Pennsylvania. Illustrated description of this new building and its equipment. 4500 w. Eng Rec—Oct. 20, 1906. No. 79885.

Transition-Curves.

A Simplified Method of Laying Out Transition-Curves. Thomas Alexander Ross. Gives a transition-curve table, explaining its use. 700 w. Inst of Civ Engrs—No. 3585. No. 79519 N.

MUNICIPAL.

Sewage.

A Method for Testing and Comparing Sewage Sprinklers. Earle B. Phelps. A preliminary description of the methods of testing employed at the Sewage Experiment Station of the Massachusetts Institute of Technology, and of the mathematical analysis of the results. 2200 w. Eng News—Oct. 18, 1906. No. 79834.

Discussion of Papers 3560 and 3599. Joint discussion of papers by David Ernest Lloyd-Davies and by Alfred Stowell Jones and William Owen Travis. Ills. 45000 w. Inst of Civ Engrs—Jan. 16 and 23, 1906. No. 79512 N.

Experience With Fine-Grain Percolating Filters for Sewage. Statements from the report of Dr. George Reid concerning experiments made in connection with the operation of a sewage filter at Hanley, England. 2200 w. Eng Rec—Oct. 20, 1906. No. 79888.

Experience with Intermittent Filtration of Sewage at Worcester, Mass. Reviews the recent report of Harrison P. Eddy concerning the operation of these filters. 5000 w. Eng Rec—Oct. 13, 1906. No. 79787.

On the Elimination of Suspended Solids and Colloidal Matters from Sewage. Alfred Stowell Jones, and William Owen Travis. Discusses the constituents of sewage, their qualities and methods of displacement, claiming that bacteria play only an auxiliary part in the purification, and showing the necessity for complete removal of several matters before the final oxidation processes. Ills. 10000 w. Inst of Civ Engrs—No. 3599. No. 79511 N.

The Advance in Sewage Disposal. An informal discussion of this subject at the annual convention, June 28, 1906. 4500 w. Pro Am Soc of Civ Engrs—Sept., 1906. No. 79535 E.

The Influence of the Saline Constituents of Sea Water on the Decomposition of Sewage. J. E. Purvis and C. J. Coleman, in the *Jour. of the Roy. San. Inst.* Aims to show how far the salts affect decomposition, and particularly with regard to the production of nitrates. 3000 w. Eng News—Oct. 11, 1906. No. 79717.

The Sewerage of Baltimore. Calvin W. Hendrick. An interesting account of this great project for treating 300,000,000 gallons of sewage per day, and the difficulties to be overcome. 3000 w. Munic Engng—Oct., 1906. No. 79732 C.

We supply copies of these articles. See page 479.

The Elimination of Storm-Water from Sewerage Systems. David Ernest Lloyd-Davies. A report of investigations and experiments made to obtain reliable information on the subject of storm-flow in underground channels, rates of rainfall, etc. 5000 w. Inst of Civ Engrs—No. 3560. No. 79510 N.

WATER SUPPLY.

Cincinnati.

The New Cincinnati Water Works. Notes regarding these improvements, based on recent papers by George H. Benzenberg, and by E. C. Manahan. 4800 w. Eng Rec—Oct. 13, 1906. No. 79786.

Color Test.

A Delicate Color Test for Copper, and a Microchemical Test for Zinc. Harold C. Bradley. Shows the delicacy of tests made with haematoxylin in copper sulphate solutions of varying strengths, and suggests its use in testing drinking water from reservoirs treated with copper sulphates. Also a zinc test with sodium nitroprusside is described. 900 w. Am Jour of Sci—Oct., 1906. No. 79714 D.

Conduits.

A Novel Design for a Reinforced Concrete Water-Works Conduit. Gives details of a conduit recently built for a southern city. Ills. 800 w. Eng News—Oct. 4, 1906. No. 79619.

Dams.

See Civil Engineering, Construction.

Filtration.

The Development of Mechanical Filtration. Robert E. Milligan. Illustrates and describes examples of plants and their operation. Followed by general discussion. 7000 w. Jour W Soc of Engrs—Oct., 1906. No. 80005 D.

The Life-History for Eight Years of the Experimental Coke and Clinker Filter-Beds at Kingston-on-Thames. Douglas Archibald. An interesting report of results from these beds. 4000 w. Jour Roy San Inst—Oct., 1906. No. 79761 D.

Works for the Purification of the Water Supply of Washington, D. C. Allen Hazen and E. D. Hardy. An account of the steps leading up to the construction of this sand filtration plant, and a description of some of the more important and novel features of its construction and operation. Ills. 15500 w. Pro Am Soc of Civ Engrs—Sept., 1906. No. 79532 E.

Fire Protection.

Water Problems Concerning Fire Protection in Cities. S. H. Lockett. From a paper read at Yale University. Discusses the situation in most cities, and the systems in use, pressure, distribution systems, and related topics. 2500 w. Munic Engng—Oct., 1906. No. 79735 C.

Ground Water.

A Remarkable Influx of Iron and Manganese into the Underground Water Supply of Breslau, Germany. Translated by Allen Hazen, from *La Technique Sanitaire*. Reports a singular change in the mineral composition of the water, rendering it no longer usable for industrial purposes. 2800 w. Eng News—Oct. 4, 1906. No. 79621.

Irrigation.

Irrigation Works of the Canadian Pacific Railway, near Calgary, Alberta. An illustrated account of this great engineering work. 2500 w. Can Engr—Oct., 1906. No. 79759.

The Canadian Pacific Railway Company's Irrigation Project. Kittredge Wheeler. An illustrated description of the work to be carried out in Southern Alberta. 1600 w. Sci Am—Oct. 20, 1906. No. 79871.

The Truckee-Carson Project of the United States Reclamation Service. W. P. Hardesty. An illustrated detailed description of this great engineering project for the reclamation of about 350,000 acres of land, at an estimated cost of $9,000,000. 12000 w. Eng News—Oct. 18, 1906. No. 79830.

Pumping.

High-Pressure Gas Power Pumping System. Illustrated description of a special system for fire protection at Coney Island, N. Y. 1300 w. Engr. U S A—Oct. 1, 1906. No. 79598 C.

Water-Pumping Installation for Burma. Illustration and brief description of an interesting plant for the oil-fields. It is one of the largest vertical direct-acting single-pumping plants yet constructed. 400 w. Engng—Sept. 21, 1906. No. 79585 A.

Purification.

Sulphate of Iron and Caustic Lime as Coagulants in Water Purification. Joseph W. Ellms. Read at meeting of Central States Water-Works Assn. Discusses the objections to their use and the advantages, giving the cost of this process. 3500 w. Eng News—Oct. 4, 1906. No. 79625.

Sulphate of Iron and Caustic Lime as a Coagulant in Water Sedimentation. W. A. Patton. Read before the Central States Water-Works Assn. Gives a report of the writer's experience at plants in Kentucky and West Virginia. 2000 w. Eng News—Oct. 4, 1906. No. 79626.

The Use of Copper Sulphate in the Purification of Water. Leo F. Rettger, and H. B. Endicott. Reports the results of a study of the action of copper sulphate on a number of micro-organisms. 1400 w. Eng News—Oct. 25, 1906. No. 80090.

Regulations.

Regulations of the Engineering Bureau, Board of Water Supply, New York. Gives some of the regulations prepared

to insure uniform and correct methods. 3500 w. Eng Rec—Sept. 29, 1906. No. 79559.

Standpipe.

A Large Reinforced Concrete Standpipe. A standpipe 50 ft. in diameter, 106 ft. high, with a capacity of 1,500,000 gals. recently put in service at Attleboro, Mass., is illustrated and described. 5500 w. Eng Rec—Sept. 29, 1906. No. 79554.

Stave Pipe.

Additional Information on the Durability of Wooden Stave Pipe. Arthur L. Adams. Facts concerning the pipe line at Astoria, Ore., which has proven deficient in durability. 1000 w. Pro Am Soc of Civ Engrs—Sept., 1906. No. 79531 E.

Supply.

Progress on the Catskill Mountain Water Supply for New York City. Outlines the proposed works for providing by gravity an additional supply for New York City, and the preliminary work already completed. Ills. 3500 w. Eng Rec—Oct. 13, 1906. No. 79783.

The New Water Supply of Franklin, N. H. Information regarding improvements, taken from the report of F. L. Fuller. 2200 w. Eng Rec—Oct. 27, 1906. No. 80113.

WATERWAYS AND HARBORS.

Atchafalaya River.

The Atchafalaya River: Some of Its Peculiar Physical Characteristics. J. A. Ockerson. An illustrated general description of an unusual stream, which is largest at its source and deepest in places of excessive width. Gives statistics of levee construction. 3500 w. Pro Am Soc of Civ Engrs—Sept., 1906. No. 79534 E.

Canal Traction.

Electric Operation of the Teltow Canal. Frank C. Perkins. Illustrated description of the system in use on this important German waterway. 2200 w. Elec Rev, N Y—Sept. 29, 1906. No. 79542.

Electric Traction on the Teltow Canal near Berlin (Le Halage Electrique des Bateaux sur le Canal de Teltow pres de Berlin). F. Hofer. With photographs of the electric hauling car and electric tow boat, and general plan of the canal and locks. 3000 w. 1 plate. Génie Civil—Oct. 6, 1906. No. 79912 D.

The Teltow Canal. An illustrated description of this recently completed artificial waterway, one of the largest ever constructed. 1600 w. Sci Am—Oct. 13, 1906. No. 79755.

Cranes.

Counterbalanced Dock Crane of 150 Tons Capacity (Hammerwippkran für 150 t. Grösste Last). A. Böttcher. Illustrating the construction of a powerful radial crane of variable radius, arranged to stand at the edge of the dock wall; constructed by the Duisburg Machine Works. Complete structural details are given. Serial. Part 1. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 6, 1906. No. 79905 D.

140-Ton Floating Crane. Illustrated detailed description of this appliance and its operation. 1800 w. Engr, Lond—Sept. 21, 1906. No. 79592 A.

Dams.

See Civil Engineering, Construction.

Defence-Works.

Sea-Coast Defence-Works in the Netherlands. Harco Theodorus Hora Siccama. Illustrates and describes some of the methods employed to protect the coast from erosion. 4000 w. Inst of Civ Engrs—No. 3590. No. 79516 N.

Sea Defences in Ferro-Concrete. Short illustrated description of a method of protection of embankments adopted in Zeeland, Holland. 700 w. Engng—Oct. 19, 1906. No. 80139 A.

Dock.

The New Dock of the French Trans-Atlantic Line at Havre (La Nouvelle Gare Maritime de la Compagnie Générale Transatlantique au Havre). A. Dumas. A fully illustrated description of the new terminal docks of the French Transatlantic line; showing the great convenience to the passengers. 2500 w. 1 plate. Génie Civil—Sept. 22, 1906. No. 79909 D.

Dredging.

The Cost of Deep-Water Dredging with a Clam-Shell Dredge for the Stony Point Extension of the Buffalo, N. Y., Breakwater. Emile Low. Explains the conditions and the work and gives an estimate of the cost of dredging. 1000 w. Eng News—Oct. 11, 1906. No. 79721.

The Work of a Ladder Dredge and Belt Conveyor System on the Fox River, Wisconsin. L. M. Mann. States the requirements of the work, and gives an illustrated description of the conveyor dredge which fulfilled the conditions. 1800 w. Eng News—Oct. 25, 1906. No. 80089.

Flow.

An Examination of the Formulas for the Flow of Water in Practical Service (Streiflichter über die Bewegungsformeln des Wassers im Dienste des Wasserbaues) W. Plenkner. A comparison of the various modifications of the Chezy formula with the results obtained in actual gaugings. 6000 w. Oesterr Wochenschr f d Oeffent Baudienst—Oct. 6, 1906. No. 79979 D.

Inland Navigation.

The Royal Commission on Canals and Waterways. Gives evidence of witnesses examined by the Commission which contains information as to the present condition of English waterways and their

future prospects. 3000 w. Engr, Lond—Oct. 12, 1906. Serial. 1st part. No. 80058 A.

Locks.

A Double-Chamber Lock System (Doppel kammer Schleuse mit Inertie wasser spar werk). A. Budan. Describing a system in which the flow of water between the lock chambers is utilized for driving the pumps. Two articles. 9000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 14, 21, 1906. No. 79932, each D.

Panama.

A Request for Bids for the Construction of the Panama Canal on a Percentage Basis. A letter from T. P. Shonts to the Secretary of War stating reasons for adopting this plan. 2800 w. Eng News—Oct. 11, 1906. No. 79723.

Mechanical Equipment of the Panama Canal. Charles W. Burke. Describes some of the machinery placed on the Isthmus by the original French company, explaining why it has proved useless, and describing the machines substituted. Ills. 3300 w. Eng Rec—Oct. 27, 1906. No. 80108.

Panama—Past and Present. W. J. Karner. An illustrated article describing the country and briefly reviewing its history and the canal project to date. Map. 4500 w. Jour W Soc of Engrs—Oct., 1906. No. 80004 D.

The Form of Contract for the Completion of the Panama Canal, on Which Bids are to be Received Dec. 12. Presents the terms of the contract on which bids are invited. Also editorial explaining what the contractor is to do and his chances for profit and loss. 8000 w. Eng News—Oct. 18, 1906. No. 79832.

Silt.

Silt and Scour. A discussion of the theories of silt and scour, and their errors, reviewing the opinions and arguments of Bellasis. 4000 w. Engr, Lond—Oct. 19, 1906. No. 80145 A.

MISCELLANY.

Australasia.

Engineering Work in Australasia: a Retrospect. Edward Dobson. An account of the engineering work during the past 55 years. 4800 w. Inst of Civ Engrs—No. 3613. No. 79518 N.

Colorado.

Engineering in the Pike's Peak Region. John Birkinbine. Discusses some of the special problems that have been, or are yet to be solved by engineers in the vicinity of Pike's Peak—the railroads, water problems, etc. Ills. 6000 w. Cassier's Mag—Oct., 1906. No. 79523 B.

Fire Losses.

Conclusion from the San Francisco Conflagration. S. Albert Reed. Extracts from a report to the Committee of Twenty, National Board of Underwriters, giving the more important lessons from this great fire. 2800 w. Munic Engng—Oct., 1906. No. 79733 C.

ELECTRICAL ENGINEERING

COMMUNICATION.

Space Telegraphy.

The Audion. Lee de Forest. An interesting account of the development of a new receiver for wireless telegraphy. 9500 w. Pro Am Inst of Elec Engrs—Oct., 1906. No. 80098 D.

The Design and Construction of a 100-Mile Wireless Telegraph Set. A. Frederick Collins. Illustrated detailed description of the sending and receiving apparatus. 3500 w. Sci Am Sup—Oct. 6, 1906. No. 79635.

The International Spark Telegraphy Conference. Editorial on some of the questions under discussion and the important interests at stake. 3300 w. Engng—Oct. 19, 1906. No. 80142 A.

The Latest form of Stations for Wireless Telegraphy on the Telefunken System (Beschreibung der Neuesten Form von stationen für Drahtlose Telegraphie nach der System Telefunken). K. Solff. Illustrating the wiring, arrangement of antennaë, and instruments, with details of the stations at Scheveningen, and in Java and Cuba. 3500 w. Elektrotech Zeitschr—Sept. 20, 1906. No. 79951 B.

The Status of the Liquid Barretter. An explanation of this electrolytic detector invented by Fessenden, and an account of the suits brought for assertions of ownership. 1000 w. Sci Am—Oct. 20, 1906. No. 79869.

Wireless Telegraphy in Railway Signalling (Die Drahtlose Telegraphie im Eisenbahn-Sicherungsdienst). Eugen Nesper. Experiments upon the Prussian Military Railway show that wireless signals may be sent 12 kilometres without interfering with the regular telegraph service, using ordinary operators. 3500 w. Elektrotech Zeitschr—Sept. 27, 1906. No. 79957 B.

Telegraphy.

Improved Telegraph Switchboard Arrangement for Use with Storage Batteries (Verbesserte Schalteinrichtung für die im Telegraphenbetriebe Verwendeten Sammler batterien). G. Knopf. Describ-

ing the former and modern switchboard systems of the German government telegraphs. 4500 w. Elektrotech Zeitschr—Oct. 4, 1906. No. 79958 B.

Telephony.

Notes on the Development of Telephone Service. Fred De Land. A review of the history and development of the telephone. 7000 w. Pop Sci M—Nov., 1906. Serial. 1st part. No. 80064 C.

The Use of the Telephone in the Permanent Seacoast Defenses of the United States. M. C. Sullivan. Briefly calls attention to the changes due to the use of the telephone, and also explains the system of range-finding and fire-control used. 1000 w. Elec Rev, N. Y.—Oct. 6, 1906. No. 79636.

DISTRIBUTION.

Control.

A New Method of Controlling the Voltage and Insulation of a Network. Dr. M. Kallmann. Abstract translation from *Elektrotechnische Zeitschrift*. Describes apparatus which responds both to voltage fluctuations and to breakdowns of the insulation. 800 w. Elect'n, Lond—Oct. 12, 1906. No. 80052 A.

Currents.

The Limits of Alternating and Direct Currents for City Service (Die Grenzen der Verwendung von Drehstrom und Gleichstrom bei Stadtzentralen). Edmund Suchy. With formulas and diagrams showing the cost of distribution and the conditions which determine the choice of system. 2000 w. Elektrotech u Maschinenbau—Oct. 14, 1906. No. 79969 D.

Rectifiers.

Some Observations on Alternating Current Rectifiers. A. C. Jolly. Considers briefly machines of the permutator type, and the electrolytic rectifier of the modern type. 1200 w. Elect'n, Lond—Oct. 12, 1906. No. 80050 A.

The Rectification of Currents by the Mercury Vapor Apparatus (Stromwandlung durch Quecksilber Vakuum Apparate). Arthur Libesny. Illustrating a variety of mercury-vapor tubes for the conversion of alternating into direct currents. Two articles. 5000 w. Elektrotech u Maschinenbau—Sept. 30, Oct. 7, 1906. No. 79967, each D.

Self Induction.

Oscillations of High Pressure and Frequency in Continuous-Current Circuits (Ueber Schwingungen mit Hoher Spannung und Frequenz in Gleichstromnetzen). C. Feldmann and J. Herzog. Showing how the self-induction of distributing cables may, under sudden changes, produce dangerous oscillations; thus accounting for breakdowns. Two articles. 10000 w. Elektrotech Zeitschr—Sept. 27, Oct. 4, 1906. No. 79955, each B.

Southern France.

The Distribution of Electrical Energy in the Mediterranean Departments (Les Distributions d'Energie Électrique dans les Départments Voisins de la Méditerranée). A. Bidault des Chaumes. An account of the great electric generating stations in the South of France, and the distribution of energy on the Mediterranean littoral. Serial. Part 1. 2500 w. Génie Civil—Oct. 13, 1906. No. 79914 D.

Wind Pressure.

Wind Pressure on Cylindrical Conductors. A. J. Bowie, Jr. Gives an outline of the theory connected with the determination of K in the formula given, and of the methods employed in experimentally verifying these determinations. Also editorial. 2500 w. Elec Wld—Sept. 29, 1906. No. 79545.

Wiring.

A New Method of Employing Twin Lead-Covered Wire for Electric Light Wiring. E. L. Berry. Calls attention to the defects in metal tube, and in wood casing, and suggests a substitute which is illustrated and described. 3000 w. Elec Engr, Lond—Sept. 28, 1906. No. 79688 A.

Uniform Symbols for Wiring Plans. Gives the symbols adopted by the National Electrical Contractors' Association of the United States. 600 w. Eng News—Oct. 11, 1906. No. 79722.

ELECTRO-CHEMISTRY.

Battery.

The Decker Primary Battery. Prof. Francis B. Crocker. Read before the Am. Elec.-Chem. Soc. Remarks on the little progress made in batteries, and their defects, and an illustrated description of the battery named, which the writer considers a remarkable advance in the primary battery art. 3500 w. Sci Am Sup—Oct. 13, 1906. No. 79756.

Corrosion.

The Corrosion of Iron Electrodes by Earth Currents. F. Haber and F. Goldschmidt. Abstract translation. Considers the problem from the electrochemical side. 1200 w. Elect'n, Lond—Sept. 28, 1906. No. 79698 A.

The Effect of Earth Return Current on Iron Pipes. Considers the experiments being carried out in Germany by Messrs. Haber and Goldschmidt, as reported in the *Zeitschrift für Elektrochemie and E. T. Z*: Gives the conclusions reached. 1400 w. Elec Rev, Lond—Sept. 21, 1906. No. 79575 A.

Electric Furnace.

The Gin Electric Steel Furnace. Frank C. Perkins. Illustrates and describes this electric furnace for metallurgical purposes. 1000 w. Min Wld—Oct. 20, 1906. No. 80013.

We supply copies of these articles. See page 479.

Electroplating.

Platinum Plating and Its Execution. Gives results of experiments which show that platinum may be deposited as easily as gold. 1400 w. Brass Wld—Oct., 1906. No. 80068.

The Production of Hard Gold Deposits for Buffed Work. Gives methods of obtaining a hard deposit that will stand buffing. Ills. 1500 w. Brass Wld—Oct., 1906. No. 80069.

Graphite.

The Manufacture of Graphite and Amorphous Carbon (Die Technische Gewinnung von Graphit und Amorphem Kohlenstoff). E. Donath. Discussing especially the reactions involved in the production of graphite by Acheson, in the electric furnace. 4000 w. Stahl u Eisen —Oct. 15, 1906. No. 79947 D.

Nitrogen.

The Birkeland-Eyde Process and the Artificial Production of Nitrates from the Atmosphere. M. Alger. Illustrates and describes the plant in Norway, for removing nitrogen from the atmosphere by electrical processes for the purpose of employing it as a fertilizer. 900 w. Sci Am —Oct. 6, 1906. No. 79633.

The Fixation of Atmospheric Nitrogen. Gives abstracts of the papers on this subject presented at the Dresden meeting of the German Bunsen Society. 3000 w. Engr, Lond—Sept. 21, 1906. No. 79590 A.

Sugar Analysis.

Electro-Decolorization—A Study in Optical Sugar Analysis. F. G. Wiechmann. Abstract of an address before the Int. Com. for Uniform Methods of Sugar Analysis, at Berne, Switzerland. A report of experiments made. 3000 w. Elec-Chem of Met Ind—Oct., 1906. No. 79657 C.

ELECTRO-PHYSICS.

Eddy Currents.

An Investigation of Eddy Currents in Sheet Iron (Beitrag zur Untersuchung der Wirbelströme in Eisenblechen). A. Kühns. Data and results of tests upon sheets of various thicknesses to determine eddy-current coefficients for use in Steinmetz's formula. 5000 w. Elektrotech Zeitschr—Sept. 27, 1906. No. 79956 B.

Electric Waves.

The Use of the Wehnelt Interrupter with the Righi Exciter for Electric Waves. A. D. Cole in the *Physical Review.* Describes the method of using the Wehnelt interrupter, and its application to demonstration purposes. Ills. 2000 w. Elect'n. Lond—Oct. 19, 1906. No. 80134 A.

Electromotive Force.

Generation of E. M. F. by Centrifugal Force. E. F. Nichols. Translated from *Phys. Zeit.* An account of experimental investigations giving results which show that the positive ions are not the chief carriers of the electric current in aluminum. 1400 w. Elect'n, Lond—Oct. 19, 1906. No. 80135 A.

Harmonics.

A New Method of Decomposing a Periodical Curve into its Harmonics (Eine Neue Methode zur Zerlegung einer Periodischen Kurve in Ihre Harmonischen). K. H. Haga. Describing a graphical method of analyzing the curves of alternating currents, and similar oscillations. 1200 w. Elektrotech u Maschinenbau—Sept. 23, 1906. No. 79964 D.

Hysteresis.

The Hysteresis Exponent Experimentally Determined. E. L. Weber. Gives an experimental method of determining the value of the hysteresis exponent in a choking coil, or transformer, of closed magnetic circuit. 500 w. Elec Wld—Sept. 29, 1906. No. 79547.

Liquid Films.

The Disruptive Voltage of Thin Liquid Films Between Iridio-Platinum Electrodes. P. E. Shaw. Read before the Physical Society. An account of research work, explaining methods used and results. 3500 w. Elect'n, Lond—Oct. 5, 1906. No. 79800 A.

Magnetic Field.

The Production of a Rotary Magnetic Field Considered Graphically. A graphical proof of the fundamental theorem which underlies the principle of action of the production of rotary magnetic fields. 1200 w. Elec Engr, Lond—Sept. 28, 1906. No. 79685 A.

Magnetic Induction.

Limitations of the Ballistic Method for Magnetic Induction. A. Hoyt Taylor, in the *Physical Review.* Reports an investigation of discrepancies found, with a view to determining their quantitative effect on cyclic curves of magnetization, and of devising a means of eliminating them. 1800 w. Elect'n, Lond—Oct. 5, 1906. No. 79798 A.

Thermo-Electricity.

Recent Investigations upon Thermo-Electric Substances (Neuere Beobactungen an Thermoelektrischen Wirkenden Körpern). A. Heil. Describing the author's improvements in thermo-electric batteries, and their application to the utilization of the heat of waste gases. 3000 w. Elektrotech Zeitscher—Oct. 4, 1906. No. 79960 B.

Windings.

Methods of Winding for the Generation of Harmonic Electromotive Forces (Ueber Einige Wicklungsanordnungen sur Erzeugung Harmonischer Elektromotorischer Kräfte). Chr. Bäumler. A mathematical discussion of the influence of coil windings upon the wave form of the currents generated. 4000 w. Elektrotech Zeitschr—Sept. 20, 1906. No. 79952 B.

We supply copies of these articles. See page 479.

GENERATING STATIONS.

Alternators.

Alternating Current Generators. P. M. Lincoln. Notes on their construction, performance and operation. Ills. 1200 w. Elec Jour—Oct., 1906. Serial. 1st part. No. 79894.

Australia.

The Traawool Scheme. An account of the irrigation and power proposal for providing an ample supply of water to northern and north-western Victoria, and for generating electricity for the supply of several towns. 2500 w. Aust Min Stand—Sept. 26, 1906. No. 80151 B.

Birmingham, Eng.

Birmingham Electric Supply. Illustrated detailed description of the Summerlane Station recently opened. 2500 w. Elec Engr, Lond—Oct. 12, 1906. Serial. 1st part. No. 80043 A.

Breakdowns.

Breakdowns of Electrical Machinery. Michael Longridge. Abstracts from annual report, discussing some of the typical breakdowns, the causes that lead to them, and the lessons they convey. 3800 w. Mech Engr—Oct. 13, 1906. Serial. 1st part. No. 80041 A.

Central Stations.

Central Station Light, Heat and Power Principles. Newton Harrison. Considers the effects of frequency, the synchronous and induction motor, effects of inductance, varying the power factor, the wattmeter, and various other subjects. 1500 w. Cent Sta—Oct., 1906. No. 79746.

Construction.

The Construction of Modern Electrical Machinery (Moderne Anschauungen über die Konstruktion Elektrischer Maschinen). E. Ziehl. A review of standard practice in the construction of dynamos and motors and of rotary converters, showing the extent to which designs have become systematized. 5000 w. Elektrotech Zeitschr—Oct. 11, 1906. No. 79962 B.

Hydro-Electric.

A Modern Swiss Hydro-Electric Power Station. Enrico Bignami. A handsomely illustrated description of the station at Obermatt, supplying power for the Stanstad-Engelberg electric railway. 3500 w. Engineering Magazine.—Nov., 1906. No. 79994 B.

Boffalora-Ticino Hydro-Electric Power Plant. Dr. Alfred Gradenwitz. Illustrated description of the plant supplying electrical energy to the cities of Milan, Pavia, Novara, and Vigevano. 900 w. Sci Am Sup—Oct. 27, 1906. No. 80095.

Developing Electricity from the Susquehanna. A. William Field. An illustrated account of the great dam being constructed at McCall Ferry, 60 miles from Philadelphia, intended to develop electric power to the capacity of from 75000 to 100000 h. p. 2000 w. Mfrs Rec—Oct. 4, 1906. No. 79596.

The Developments of Water Power in the Province of Ligure, Italy. Information concerning development work of interest from the ingenuity of the method of cheapening the hydraulic engineering connected with the schemes. 1600 w. Elec Rev, Lond—Sept. 21, 1906. No. 79576 A.

The Hydro-Electric Station of the Greenville-Carolina Power Co. William S. Ide. Illustrated description of a low-head water-power development supplying electric power for municipal, railway and industrial purposes. 4500 w. Eng Rec—Oct. 6, 1906. No. 79667.

The Necaxa Plant of the Mexican Light and Power Company. F. S. Pearson and F. O. Blackwell. Describes and illustrates a water-power developed and transmitted to the cities of Mexico and Puebla, and to the mining camps of Pachuca and El Oro. 3000 w. Pro Am Soc of Civ Engrs—Oct., 1906. No. 80101 E.

Load Factor.

The Influence of Load Factor and Prime Mover Characteristics on Power Station Economy. J. R. Bibbins. A discussion based upon views set forth in the transactions of the Am. Inst. of Elec. Engrs., Feb., 1906. Considers only engine characteristics and load factor. 2200 w. Elec Jour—Oct., 1906. No. 79895.

The Load Factor of Electric Distribution Plants (Der Belastungsfaktor Elektrischer Kraftverteilungs Anlagen). Norberg Schulz. A discussion of the performance of a number of generating stations in Sweden, with a number of load curves from the more important plants. 3500 w. Elektrotech Zeitschr—Sept. 13, 1906. No. 79949 B.

The Value and Design of Water Power Plants as Influenced by Load Factor. Dr. Frederic A. C. Perrine. A study of this problem as affecting hydro-electric plants. 3500 w. Jour Fr Inst—Oct., 1906. No. 79728 D.

Operation.

Abnormal Operating Conditions of Electrical Apparatus. A. E. Buchenberg. Gives information and results prepared for central station men, showing the difficulties following any deviation from normal operating conditions. 2000 w. Elec Wld—Oct. 6, 1906. No. 79675.

Parallel Running.

The Parallel Operation of Alternators (Ueber den Parallelbetrieb von Wechselstrommaschinen). Dr. L. Fleischmann. Deriving formulas for arranging the parallel operation of alternators of different electrical and mechanical design. 2500 w. Elektrotech Zeitschr—Sept. 20, 1906. No. 79950 B.

We supply copies of these articles. See page 479.

Polarity.

Correcting Reversed Polarity in Large Generators. H. R. Mason. Discusses the best methods to use with different types. 1700 w. Power—Nov., 1906. No. 80079 C.

Power.

The Generation and Transmission of Power. Summarizes the practice in power station design, equipment and operation, storage batteries, voltages, sub-stations and portable sub-stations. Ills. 10000 w. St Ry Jour—Oct. 13, 1906. (Convention Sec.) No. 79818 C.

Power Load.

Adjuncts to the Power Load. From a paper by C. J. Russell, read before the Assn. of Edison Illuminating Companies, discussing the possibilities of electric heating and of electro-chemical processes for increasing the central load, and leveling the load curve. 4500 w. Elec Wld—Oct. 6, 1906. No. 79676.

Scranton, Pa.

Power Plant of the Lackawanna Light Company of Scranton, Pa. Illustrated detailed description of the station and its equipment, the underground system serving the business section and the overhead district. 2000 w. Elec Wld—Oct. 6, 1906. No. 79673.

Supply.

Some Practical Notes on the Commercial Development of Electricity Supply Undertakings. R. Borlase Matthews. Discusses the need in England of a business-getting campaign in the electrical field. 1800 w. Elec Rev, Lond—Oct. 19, 1906. No. 80131 A.

Transformers.

Current Transformers for Instruments. States the requirements of current transformers, and investigates the determining features of the design. 1300 w. Elec Rev, Lond—Oct. 12, 1906. No. 80045 A.

The Treating of Transformer Oil. S. M. Kintner. Remarks on the detrimental effect of the presence of water to the insulating qualities of oil, and discussion of the ways of effecting a separation of oil and water. 2000 w. Elec Jour—Oct., 1906. No. 79897.

Transformer Design. A. Coggeshall. Aims to show how the size and weight of a transformer vary with the capacity and the density, and how the density at which the minimum losses obtain is readily found and the performance of the transformer predetermined. 600 w. Elec Wld—Oct. 13, 1906. No. 79773.

LIGHTING.

Arc Lamps.

The Series Luminous Arc Rectifier System. N. R. Birge. Read before the Ohio Elec. Lgt. Assn. Illustrates and describes the construction and operation of this system. 1600 w. Engr, U S A—Oct. 1, 1906. No. 79599 C.

Charges.

The Price of Electricity. Robert Sever Hale. A discussion of the proper basis or unit of charge for an electric light company. 7000 w. Tech Qr—Sept., 1906. No. 80001 E.

Churches.

The Lighting of Churches. J. R. Cravath and V. R. Lansingh. Gives illustrations showing the lighting of various churches, with critical discussions of the methods used. 2000 w. Elec Wld—Oct. 6, 1906. No. 79674.

Illumination.

The Distribution of Illumination in the Neighborhood of a Row of Lamps. J. R. Benton. States formulas from which information concerning the illumination to be expected from such an arrangement, can be obtained, and matters of related interest. 2000 w. Elec Wld—Oct. 27, 1906. No. 80115.

Incandescent.

Improved Incandescent Lamps (Neuere Elektrische Glühlampen). Dr. Feichmüller. Comparative costs of lighting with carbon filaments, and with tantalum, osmium, and other metallic filaments. 1500 w. Elektrotech Zeitschr—Sept. 20, 1906. No. 79954 B.

Modern Forms of Electric Incandescent Lamps. Dr. C. R. Böhm. Abstract translation from *Elektrotechnischer Anzerger*. A summary of recent developments and the various filaments used, with an appendix by Prof. Alfred Lottermoser on colloids. 7000 w. Elect'n, Lond—Sept. 21, 1906. No. 79579 A.

Modern Glow Lamps with Metallic Filaments. Gives information concerning some of the new lamps which use metallic filaments of exceedingly high melting points. 1600 w. Elec Rev, Lond—Oct. 5, 1906. No. 79796 A.

Lamp Suspension.

Self-Sustaining Winch and Arc Lamp Suspension Gear. Illustrates and describes an interesting winch for lowering or raising arc lamps. 1000 w. Elec Engr, Lond—Oct. 12, 1906. No. 80044 A.

Mercury Arc.

The Mercury Arc: Its Properties and Technical Applications. E. Weintraub. Considers the structure of the mercury arc, the properties of the cathode, the starting, stability, etc., arcs in other metallic vapors, alternating-current phenomena, arcing and technical applications. 9500 w. Jour Fr Inst—Oct., 1906. No. 79727 D.

Photometry.

See Electrical Engineering, Measurement.

Train Lighting.

See Railway Engineering, Motive Power and Equipment.

Wind Power.

Electric Lighting by Wind Power. E.

Lancaster Burne. A study of this subject, considering the wind itself, the motor, and the installation as a whole. 5000 w. Elec Rev, Lond—Oct. 19, 1906. No. 80130 A.

MEASUREMENT.

Brushes.

The Measurement of the Transition Resistance of Metal-Carbon Brushes (Die Messung der Uebergangswiderstände von Metall-Kohlen-Bürsten). S. Salto. Data and results of tests of brushes, made of carbon containing copper, bronze or other metals to improve the conductivity. 1200 w. Elektrotech Zeitschr—Sept. 20, 1906. No. 79953 B.

Conductivity.

Measurement of Electrical Conductivity of Short Rods. Rollo Appleyard. Considers the general principles of construction for an instrument designed for making rapid measurements of rods of iron, steel and alloys. 4000 w. Inst of Civ Engrs—No. 3603. No. 79514 N.

Errors.

The Calculation of Percentage Error. H. G. Solomon. Explains the value and meaning of percentage error of an instrument, and gives methods of calculation. 1700 w. Elec Rev, Lond—Oct. 5, 1906. No. 79795 A.

Galvanometers.

Factors Determining the Design of Needle Galvanometers. L. A. Freudenberger. Develops the formulas for maximum sensibility in needle galvanometers. 600 w. Elec Wld—Sept. 29, 1906. No. 79546.

The Theory of the "Moving Coil" and Other Kinds of Ballistic Galvanometers. Prof. Harold A. Wilson. Presents the formula usually given for ballistic galvanometers, and also other formulæ for ballistic galvanometers of several types which differ from the first. 1000 w. Elec Rev, N. Y.—Oct. 20, 1906. No. 79881.

Meters.

Test of an Induction Meter for Single-Phase Currents (Induktions zahler mit Clockenanker für Einphasigen Wechselstrom). Report of test by the Reichsanstalt of a new meter by the Siemens & Halske Co. 1500 w. Elektrotech Zeitschr—Oct. 4, 1906. No. 79959 B.

The Kelvin Sector Ammeter and Voltmeter. M. C. Rypinski. Illustrates and describes this meter and states the advantages claimed. 1500 w. Elec Jour—Oct., 1906. No. 79898.

Oscillographs.

Oscillographs and Some of Their Recent Applications. David A. Ramsay. Calls attention to problems which the oscillograph is particularly well adapted to investigate, giving examples of results obtained. Ills. 3300 w. Elect'n, Lond—Sept. 21, 1906. No. 79578 A.

Photometry.

Color Phenomena in Photometry. J. S. Dow, before the Physical Soc. of London. Reports an extended investigation made and discusses the results. 4500 w. Elec Rev, N. Y.—Sept. 29, 1906. No. 79543.

The Sources of Error in the Harcourt 10-C.P. Pentane Standard. J. S. Dow. An account of experiments by the author on some of the possible sources of error. 2200 w. Elec Rev, Lond—Sept. 28, 1906. No. 79692 A.

Resistances.

On Methods of High Precision for the Comparison of Resistances. F. E. Smith. Gives a brief account of the high precision methods used at the National Physical Laboratory for measuring standard resistances. 2500 w. Elect'n, Lond—Oct. 5, 1906. Serial. 1st part. No. 79799 A.

Testing.

The Theory of Shop Methods of Testing Direct and Alternating Current Machinery. J. W. Rogers. Gives briefly the tests usually made, and the purposes for which they are made, and the methods of carrying out the various tests. 3000 w. Elec Engr, Lond—Oct. 5, 1906. Serial. 1st part. No. 79793 A.

MOTORS.

Alternating.

Relation of the Alternating-Current Motor to Central Station Business. Reprint of a paper by E. W. Lloyd, read before the Edison Ill. Cos. Calls attention to the necessity of the coöperation of central station men with manufacturers. 3000 w. Elec Wld—Oct. 6, 1906. No. 79679.

Construction.

See Electrical Engineering, Generating Stations.

Induction Motors.

Is the Circle Diagram for Asynchronous Induction Motors Applicable for Oversynchronism? (Gilt das Kreisdiagramm für Asynchrone Wechselstrommaschinen auch bei Uebersynchronismus). L. Lombardi. Results of tests at various speeds, showing that the circle diagram holds good at all speeds. 3000 w. Elektrotech u Maschinenbau—Sept. 30, 1906. No. 79965 D.

Interpoles.

The Design of Continuous-Current Dynamo Electric Machinery with Interpoles. Gives a brief bibliography of recent articles dealing with this subject. 4200 w. Elect'n, Lond—Sept. 28, 1906. No. 79695 A.

Pulleys.

Dynamo and Motor Pulleys. T. D. Lynch. An illustrated article presenting some of the features of a set of specifications for pulleys recently adopted by the Westinghouse Elec. & Mfg. Co. 1500 w. Elec Jour—Oct., 1906. No. 79899.

Single-Phase.

Calculation of the Characteristic Curves of the Single-Phase Series Commutator Motors. Prof. O. S. Bradstad and Stanlev P. Smith. Shows how a point-by-point method has been used to determine the characteristics of a motor when both the saturation of the iron and the effect of the currents in the short-circuited sections are taken into account. 2000 w. Elect'n, Lond—Oct. 12, 1906. Serial. 1st part. No. 80049 A.

Note on the Tractive Effort of the Single-Phase Commutator Motor Equipment. B. G. Bergman. Discusses the effect of the pulsating torque, which is characteristic of these motors, giving test results and conclusions. 1700 w. Elec Wld—Oct. 13, 1906. No. 79771.

Some Points About Single-Phase Motors. W. Langdon-Davies and B. O. Hawes. Read before the Birmingham and District Elec. Club. The types of motors dealt with are those used on ordinary single-phase circuits, supplying current for lighting and power. Reviews the motors used in this service, and considers the properties essential to a good single-phase motor, etc. 3800 w. Elect'n, Lond—Oct. 19, 1906. No. 80132 A.

See Also Street and Electric Railways.

Standardization.

Standardization of Direct-Current Traction Motors. A translation of the Committee report presented at the International Congress of Tramways at Milan. 1800 w. Elec Wld—Oct. 13, 1906. No. 79772.

TRANSMISSION.

Direct Current.

The New Power Supply for the City of Lyons, France. C. T. Wilkinson. An illustrated account of an interesting 60,000-volt direct-current transmission over a distance of 110 miles. Also editorial. 4000 w. Elec Wld—Oct. 20, 1906. No. 80019.

Lightning.

High-Tension Lightning Protection. C. R. McKay. Read before the Cent. Elec. Ry. Assn. Considers the principal high-tension, alternating-current protective devices in present use, and their performance. 2500 w. Elec Ry Rev—Oct., 1906. No. 79656.

INDUSTRIAL ECONOMY

Apprentices.

A Modern Adaptation of the Apprenticeship System. O. M. Becker. A review of present methods of training the skilled mechanics of the future, showing their possible adaptability to the average shop. 3500 w. Engineering Magazine—Nov., 1906. No. 79992 B.

Bounties.

Bounties for the Canadian Iron and Steel Industry. Edward Porritt. A survey of bounty legislation and bounty payments from 1894 to 1906. 4500 w. Ir Age—Oct. 25, 1906. No. 80085.

Contracts.

The Legal Effect and Construction of a Contract for Large Works. Considers some of the more important provisions which usually appear in large contracts, discussing the provisions of certain clauses which would be sufficient to cover every contingency. 5800 w. Engng—Oct. 12, 1906. No. 80054 A.

Education.

A Comparison of University and Industrial Discipline and Methods. Frederick W. Taylor. From an address delivered at the dedication of the Engineering Building for the University of Pennsylvania. Discussed from the point of view of the employer, having in mind the preparation for success in commercial engineering and industrial enterprises. 2300 w. Eng News—Oct. 25, 1906. No. 80092.

A Great Educational Plant Dedicated. An account of the dedication of the new engineering building of the University of Pennsylvania and its equipment for instruction in mechanical, electrical, and civil engineering. Ills. 2500 w. Ir Trd Rev—Oct. 25, 1906. No. 80103.

A Model College Engineering Building. Illustrated description of the new building for the civil and mechanical engineering departments at the University of Pennsylvania. 5000 w. Ir Age—Oct. 25, 1906. No. 80084.

Engineering Education. An informal discussion at the annual convention, June 27, 1906. 6000 w. Pro Am Soc of Civ Engrs—Sept., 1906. No. 79536 E.

Instruction in Mathematics and Physics in Higher Schools (Bericht über Mathematischen und Naturwissenschaftlichen Unterricht an Unsern Höhern Schulen). A. Gutzmer. A report discussing especially projects for educational reform in the matter of instruction in science in the German Schools. 6000 w. Zeitschr d

Ver Deutscher Ing—Oct. 6, 1906. No. 79907 D.

The Engineer as a Citizen. Address by Prof. Alexander C. Humphreys at the dedication of the new engineering building of the University of Pennsylvania. Discusses the instruction needed by engineering students to fit them for the usefulness awaiting them. Also editorial. 5000 w. Eng Rec—Oct. 27, 1906. No. 80111.

The Technical School and the University. Prof. W. H. Burr. An address on the importance of practical scientific training. 1800 w. Am Mach—Vol. 29. No. 43. No. 80080.

Industrial Relations.

The Railroads and Mining. Dr. James Douglas. From an oration before the graduating class at Columbia University. Considers some of the relations of railroad transportation in the United States to mining and metallurgy. 2000 w. Ir Age—Oct. 18, 1906. No. 79823.

Invention.

Some Principles of Sound Engineering for the Inventor. Thorburn Reid. Supplemental to an earlier article on "Exploiting an invention." Shows that successful inventions must be guided by good engineering and business sense. 4000 w. Cassier's Mag—Oct., 1906. No. 79526 B.

Patents.

Patents as a Factor in a Manufacturing Business. Edwin J. Prindle. The third paper discusses the patent knowledge necessary before the manufacturer should issue the new product. 3500 w. Engineering Magazine—Nov., 1906. No. 79991 B.

Specialization.

Specialization in Manufacturing. Alexander E. Outerbridge, Jr. Discusses the results of specialization as illustrated by America's remarkable growth. 3000 w. Cassier's Mag—Oct., 1906. No. 79528 B.

Shipping.

See Marine and Naval Engineering.

Works Management.

Some Features of Works Management and Equipment. Thomas B. O'Neill. An illustrated article explaining features of the Philadelphia plant of the Link Belt Co. 1200 w. Mach, N. Y.—Oct., 1906. No. 79611 C.

MARINE AND NAVAL ENGINEERING

Battleships.

A Further Argument for the Big Ships. Richard Wainwright. A reply to the arguments of Captain Mahan, and advocating big ships as typified by the English "Dreadnought." 2700 w. Pro U S Nav Inst—Sept., 1906. No. 79847 F.

H. M. S. "Dreadnought." Plates and editorial review of the principal features of this new battleship. 2800 w. Engng—Oct. 5, 1906. No. 79802 A.

The Battleships "Dreadnought" and "South Carolina." Illustrates these two types, based on lessons of the Japanese War, with descriptions of the important features. 2200 w. Sci Am—Oct. 27, 1906. No. 80094.

The French Battleship "Republique." Illustrated description of this new addition to the French navy. 800 w. Engr, Lond—Sept. 28, 1906. No. 79712 A.

Trials of H. M. S. "Dreadnought." A report of the very satisfactory trials of this English battleship. 1500 w. Engr, Lond—Oct. 12, 1906. No. 80060 A.

Cruisers.

New Peruvian Cruisers. Illustrates and describes the "Almirante Grau," one of two sister ships recently built for the Peruvian navy. 1200 w. Engng—Sept. 28, 1906. No. 79707 A.

Dry-Docks.

Floating Dry-Dock Construction. William T. Donnelly. Read before the Brooklyn Engrs' Club. Describes the floating dock and its operation, and illustrates various types. 2500 w. Int Marine Engng—Nov., 1906. Serial. 1st part. No. 80074 C.

The Naval Floating Dock—Its Advantages, Design and Construction. Leonard M. Cox. Principally a consideration of the floating dock, the choice of types, cost, etc. Ills. 15000 w. Pro Am Soc of Civ Engrs—Oct., 1906. No. 80099 E.

The New Rotterdam Electrically-Operated Floating Dock. Frank C. Perkins. Illustrations with brief description. 250 w. Sci Am Sup—Oct. 6, 1906. No. 79634.

Ferryboats.

The New Screw Ferryboats for the Long Island Railroad. Illustrated description of a vessel for service between Long Island City and James Slip, Manhattan. 500 w. Naut Gaz—Sept. 27, 1906. No. 79539.

Liner.

Cunard Express Steamer Mauretania. An illustrated article giving much information in regard to this new turbine steamer and matters relating to its construction. Plates. 6500 w. Engr, Lond—Sept. 21, 1906. No. 79591 A.

Motor Boats.

Oil-Engines for Marine Purposes. Editorial on the uses made of the Diesel oil-

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engine for the propulsion of vessels. 1300 w. Engng—Oct. 5, 1906. No. 79803 A.

The Coming of Explosive Engines for Naval Purposes. C. M. Chester. Presents the advantages of these engines, reviewing recent papers bearing on this subject, and urging their speedy adoption for small vessels, such as torpedo-boats. Ills. 4300 w. Pro U S Nav Inst—Sept., 1906. No. 79845 F.

The Freight Boat Venoge on the Lake of Geneva (Der Lastdampfer Venoge auf dem Genfersee). P. Ostertag. A fully illustrated account of the use of the Diesel motor, and Del Proposto electric transmission system, as commercially applied to lake navigation. 1800 w. Schweiz Bauzeitung—Sept. 29, 1906. No. 79973 B.

Oil Engine.

Two-Cycle Marine Oil Engine. Illustrated description of the new Sulzer-Diesel engine. 500 w. Engr, Lond—Oct. 12, 1906. No. 80063 A.

Protection.

Protection of Ships Against Torpedoes and Mines. Shows that existing methods of meeting torpedo or mine attack are all more or less defective, and gives the recommendations made by Dr. Blochmann, with the reasons. 4000 w. Engr, Lond—Oct. 19, 1906. No. 80143 A.

Shipping.

Shipbuilding and Shipping at Nagasaki. Information concerning the last year's work at this Japanese yard, and the improvements and extensions recently made. 1200 w Engng—Oct. 12, 1906. No. 80056 A.

Shipbuilding on the Great Lakes. Ralph D. Williams. A report of the work under order for this year's delivery, with illustrations of some of the vessels, and information concerning them. 1500 w. R R Gaz—Oct. 26, 1906. No. 80087.

Steamboats.

The American Steamboat Olympian, Ashore in the Straits of Magellan and Her Interesting Career. An illustrated article describing this paddle steamboat and giving its interesting history. 2000 w. Naut Gaz—Sept. 27, 1906. No. 79540.

Steamers.

A New Zealand Meat-Carrying Steamer. Benjamin Taylor. Illustrates and describes the twin screw steamer Orari, built for the frozen meat trade. 1000 w. Int Marine Engng—Nov., 1906. No. 80073 C.

The Fire-Proof Excursion Steamer Jamestown. Illustrated detailed description of a fine day passenger steamer intended for service between Washington and Norfolk, but now running in the excursion business on the Potomac River. 5000 w. Int Marine Engng—Nov., 1906. No. 80072 C.

Stresses.

A Graphical and Analytical Method for Determining Transverse Stresses (Zeichnerisch-Rechnerisches Verfahren zur Bestimmung der Querbeanspruchungen). J. Stieghorst. A general study of transverse stresses, extending the theory for beams to include that for the frames of vessels. Four articles. 9000 w. Schiffbau—Aug. 8, 22, Sept. 12, 26, 1906. No. 79981 each D.

Stresses in Ships. John Smith. Read before the British Assn. An application of stream-line apparatus to determine the direction and approximate magnitudes of the principal stresses in certain parts of ships. Ills. 3300 w. Engng—Sept. 28, 1906. No. 79708 A.

Tender.

Steel Lighthouse Tender Tulip. An illustrated general description of a new single-screw steel lighthouse tender for Tompkinsville, N. Y. 2700 w. Naut Gaz—Oct. 25, 1906. No. 80118.

Towing.

Note on the Towing-Resistance of a Floating Dock. Henry Aylwin Bevan Cole. An investigation made to deduce approximately the towing-resistance of the dock from the indicator horse-power of the towing steamer. 1000 w. Inst of Civ Engrs—No. 3591. No. 79515 N.

Turbine Propulsion.

Development of the Marine Steam-Turbine. C. A. Parsons and R. J. Walker. Abstract of a paper read at meeting of the Inst. of Marine Engrs. 3000 w. Engng—Oct. 5, 1906. No. 79804 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Bicycle.

Archdeacon's Air-Propelled Motor Bicycle. Brief illustrated description of this curious apparatus and its working. 500 w. Sci Am—Oct. 6, 1906. No. 79632.

Cadillac.

The 10-h. p. Cadillac Car. Gives general views of the car and chassis, and of detailed parts, with descriptive notes. 1700 w. Auto Jour—Sept. 29, 1906. Serial. 1st part. No. 79680 A.

Lubrication.

Lubrication Systems for Automobiles. Considers the importance of lubrication in internal combustion motors, the special oils and method of applying. Ills. 2000 w. Automobile—Oct. 18, 1906. No. 79865.

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The Lubrication of Cars. H. O. Duncan. Considers the essentials in a lubricant, the effects of inferior ojil, and the French system of protecting their special brands. 1800 w. Autocar—Oct. 13, 1906. No. 80037 A.

New Cars.

The Construction of the 1907 Peerless. Illustrates and describes the two new cars offered by this company, Nos. 15 and 16. 1200 w. Automobile—Oct. 11, 1906. No. 79744.

The Rapid Car. Illustrated description of the Italian-built Rapid, exhibited at the last Paris Salon. 2200 w. Auto Jour—Oct. 13, 1906. No. 80036 A.

The Waterless Knox for 1907. Illustrated description of a new touring car, with four-cylinder vertical air-cooled motor, rated at 25-30 h. p. Known as model H. 900 w. Automobile—Oct. 11, 1906. No. 79745.

Operation.

Automobile Operation. Forrest R. Jones. A discussion of details liable to cause trouble in the operation, and the means of avoiding accidents, the care needed, and matters of general interest. 4000 w. Sib Jour of Engng—Oct., 1906. Serial. 1st part. No. 80003 C.

Piston Pins.

What Is Wrong with Piston Pins in Automobile Engines—The Remedy. E. J. Bartlett. Explains the stresses the pin is subjected to and the methods of holding the pin as practiced in automobile work. Ills. 1200 w. Am Mach—Vol. 29. No. 40. No. 79617.

Racing Cars.

A Retrospect of the Vanderbilt Cup Race. A brief account of this race, illustrating some of the cars and scenes. 1500 w. Sci Am—Oct. 20, 1906. No. 79870.

The Elimination Car that Did not Start. Illustrated description of the Breese, Laurance & Moulton special racing car for the Vanderbilt Cup race. 500 w. Automobile—Oct. 18, 1906. No. 79866.

Searchlight.

Motor Searchlight Equipment. Brief illustrated description of this plant built to the order of the Tyne Division of the Royal Engineers. 300 w. Auto Jour—Oct. 20, 1906. No. 80126 A.

Steering.

Notes on the Steering of Automobiles. P. L. Renouf. Describes the Renouf system. Ills. 1200 w. Autocar—Oct. 20, 1906. No. 80124 A.

Taxation.

Motor Cars and Taxation. Discusses chiefly taxes or duties payable or proposed on motor cars in England. 2000 w. Engr, Lond—Sept. 21, 1906. No. 79589 A.

Touring Cars.

The 25-h. p. Straker-Squire "C. S. B." Touring Car. Begins an illustrated detailed description of this petrol-driven pleasure vehicle, especially the departures from usual practice. 1600 w. Auto Jour—Oct. 20, 1906. Serial. 1st part. No. 80125 A.

Tourist Trophy.

The Race of the Day—The Tourist Trophy. An account of the origin and nature of this race, illustrating the cars of the recent contest and giving an account of the race and a comparison with last year's course, etc. 9000 w. Auto Jour—Sept. 22, 1906. No. 79573 A.

The Tourist Trophy Race, 1906. An illustrated description and discussion of the recent race. 12000 w. Auto Jour—Oct. 6, 1906. No. 79789 A.

Troubles.

The Diagnosis of Motor Troubles. Harold H. Brown. Suggestions for locating troubles in four-cylinder motors. 2500 w. Automobile—Oct. 25, 1906. No. 80082.

Using Tools.

Hints on Filing, Hardening and Tempering. Directions for the use of tools in making repairs on automobiles. 2500 w. Automobile—Oct. 4, 1906. No. 79608.

Vanderbilt Cup.

The Winning Foreign Machines in the Third International Race for the Vanderbilt Cup. Illustrates seven of the eight foreign makes which took part in this race, giving brief descriptions. 2800 w. Sci Am—Oct. 13, 1906. No. 79754.

See also Mechanical Engineering, Combustion Motors.

COMBUSTION MOTORS.

Alcohol.

Digest of the Regulations and Instructions Concerning the Denaturation of Alcohol. Gives those portions of the regulations of interest to the distiller and the proprietors of redenaturing plants. 4000 w. Sci Am Sup—Oct. 20, 1906. Serial. 1st part. No. 79873.

The Problem of Denaturing Alcohol. Thomas L. White. Discusses the losses due to denaturing, the selecting of a denaturant, the conditions to be desired and related matters. 2200 w. Automobile—Oct. 18, 1906. No. 79864.

Fuel.

The Fuel Question. A Suggestion. Rankin Kennedy. Suggests the possibility of using solid fuels, in a state of fine pulverization, for internal combustion engines. 1000 w. Autocar—Oct. 13, 1906. No. 80038 A.

Gas Engines.

Gas Engines. Paul Windsor. Read at Columbus Convention of the Am. St. & Int. Ry. Engng. Assn. Deals with the experience that the Boston Elevated Ry.

Co. has had with its two gas-engine plants. Ills. 1800 w. St Ry Jour—Oct. 20, 1906. No. 80030 C.

The Experience of the Boston Elevated Railway with Gas-Producer Engine Plants. Concerning two plants, radically different in equipment, installed with the idea of obtaining information by a practical test. They seem to show the economy and reliability of gas engine power stations. Plans. 1200 w. Eng Rec—Oct. 20, 1906. No. 79884.

The Injection of Volatile Liquids in Explosion Motors (Les Moteurs à Explosion et l'Injection de Liquides Volatiles). Dr. K. Schreber. A discussion of the thermodynamics of gas engines in which a volatile liquid is injected during the compression stroke. 5000 w. Rev Gén des Sciences—Aug. 30, 1906. No. 79926 D.

Large Gas Engines. H. A. Humphrey. A lecture delivered in connection with the Engineering and Machinery Exhibition at Olympia. A review of the features of the large gas engines made in England and on the Continent. 3700 w. Jour Gas Lgt—Oct. 9, 1906. No. 79854 A.

Molding and Patternmaking of an Automobile Gas Engine. E. F. Lake. An illustrated article comparing the advantages of two-cycle and four-cycle types, and discussing the influence of automobiles on the gas-engine business, the construction, materials, etc. 2700 w. Am Mach—Vol. 29. No. 40. No. 79615.

The Influence of the Cylinder Walls upon the Efficiency of the Gas Engine. (Influence de l'Action de Paroi sur le Rendement des Moteurs à Gaz). L. Letombe. An investigation of the head losses involved in cooling the cylinder, showing the advantages of high compression, and combustion at constant volume. 5000 w. Revue de Mécanique —Sept. 30, 1906. No. 79922 E+F.

Gases.

Development of the Theory for the Kinetic Energy of Gases. Gustaf M. Westman. A mathematical study, deducing formula. 2500 w. Jour Fr Inst—Oct., 1906. Serial. 1st part. No. 79731 D.

Heat Motors.

Notes on the Thermodynamics of Heat Engines (Remarques sur la Thermodynamique des Machines Motrices). M. Jouguet. A theoretical study of the thermodynamics of gas engines and their cycles. 6000 w. Revue de Mécanique—July 31, 1906. No. 79917 E+F.

Ignition.

Apparatus for Ignition on Petrol Engines. Donald S. Munro. Brief review of the various arrangements for electric ignition, both of high and low-tension systems. Ills. 4500 w. Prac Engr—Oct. 19, 1906. No. 80127 A.

Oil Engine.

The 50-Horse-Power Four-Cylinder Crossley Vertical Oil Engine with New System of Governing. Illustration with description of the new system of governing by auxiliary air. 600 w. Sci Am Sup —Oct. 20, 1906. No. 79872.

Producers.

Experimental Studies with a Gas Producer (Untersuchungen an Gaserzeugern). Karl Wendt. Data and results of tests upon the chemical and thermal reactions in the fuel-gas producer; with tables and diagrams. 4000 w. Stahl u Eisen—Oct. 1, 1906. No. 79942 D.

Producer Gas for Power and Fuel. Julius I. Wile. Explains the production of this gas, discussing its uses, and the apparatus required, types of engines and related matters. 2800 w. Ir Age—Oct. 13, 1906. No. 79825.

Suction Gas.

Cost of Suction Gas Power. Considers things that must have a place in determining the actual cost of generation and maintenance. 3000 w. Elec Rev, Lond—Sept. 21, 1906. No. 79577 A.

Two-Cycle.

Development of the Two-Cycle Gas Engine. C. P. Malcolm. A brief history of the development, pointing out the problems that have proved difficult. 3000 w. Automobile—Oct. 25, 1906. Serial. 1st part. No. 80083.

Wolseley 2-Cycle Internal Combustion Engine. Illustrated description of a design aiming principally at economical working. 1500 w. Mech Engr—Oct. 13, 1906. No. 80039 A.

See also Marine and Naval Engineering.

See also Mechanical Engineering, Automobiles.

HEATING AND COOLING.

Air Analysis.

Air Analysis as an Aid to the Ventilating Engineer. J. Roger Preston. Prize paper. Aims to show tests of importance to ventilating engineers, giving details and drawings of apparatus. Ills. 4000 w. Heat & Vent Mag—Oct., 1906. No. 80009.

Gas Heating.

A Fan Heating System with Gas Heater. Illustrated description of the methods used in heating an engine-house at Parsons, Kansas. The equipment consists of a multi-tubular gas heater, a hot-blast heating fan, and an induced-draft fan for control of the furnace draft. 1600 w. Eng Rec—Oct. 6, 1906. No. 79670.

Heat-Economy.

Heat-Economy in Factories. Henry Alexander Mavor. A study of the conditions of heat-production and utilization in factories. Also discussion. 9500 w. Inst of Civ Engrs—No. 3561. No. 79522 N.

We supply copies of these articles. See page 479.

Hospitals.

The Warming and Ventilation of Hospitals. Charles L. Hubbard. Suggestions for successful and safe heating of this class of buildings. 3000 w. Eng Rec—Oct. 13, 1906. No. 79785.

Hot Water.

The Brueckner System of Hot-Water Heating. Shows this system as applied to a two-pipe radiator installation, to a single-pipe radiator installation, and to an installation where the heating boiler must be located considerably above the level of some of the radiation. Ills. 2000 w. Met Work—Sept. 29, 1906. No. 79537.

Refrigeration.

Different States of Ammonia in Refrigeration. Dr. J. E. Siebel. Shows the importance of the different states of ammonia, discussing boiling ammonia, wet ammonia, and saturated ammonia, efficiency obtainable, etc. 3000 w. Ice & Refrig—Oct., 1906. No. 79607 C.

Residence.

Heating and Ventilating a Country Residence. Gives plans and brief description of an indirect system of steam heating, combined with a direct, for a Long Island home. 800 w. Heat & Vent Mag—Oct., 1906. No. 80010.

Schoolhouses.

Heating and Ventilating Schoolhouses. Charles L. Hubbard. Gives statements based on many years experience in this line of work, which may be easily adapted to most buildings. 700 w. Eng Rec—Oct. 6, 1906. No. 79672.

Schools.

Mechanical Equipment of the New Stuyvesant High School, New York City. C. Dix McArthur. Plans and description of a manual training high school, where the equipment has been selected not only to serve the purpose intended, but to educate students and to make tests in connection with laboratory work. Ills. 4000 w. Heat & Vent Mag—Oct., 1906. No. 80008.

HYDRAULICS.

Air Lift.

Trial of an Air-Lift Pump. Describes the principle of this pump, and gives results obtained in a test carried out at the Wandsworth and Putney Gas Works. 1700 w. Engng—Sept. 21, 1906. No. 79588 A.

Centrifugal Pumps.

Centrifugal Pumps. P. A. Mossay and G. M. Brown. Abstract of a paper read before the Rugby Engng Soc. Briefly reviews the history of rotary pumps, considers the recent rapid development and its cause, discussing in detail the performance and construction of centrifugal pumps. 3000 w. Mech Engr—Sept. 29, 1906. Serial. 1st part. No. 79684 A.

Centrifugal Pumps and Fans at the Bavarian Exposition at Nuremberg, 1906 (Die Kreisel-Pumpen und Ventilatoren auf der Bayer Jubilaums-Landes-Ausstellung in Nürnberg, 1906). H. Fischer and H. Zeine. Illustrating especially multiple high-pressure centrifugal pumps of the leading Continental makers. 3000 w. Zeitschr f d Gesamte Turbinenwesen—Sept. 20, 1906. No. 79976 D.

Tests of a New Centrifugal Pump. Abstract of a report by Prof. J. E. Denton on tests made on a new design of centrifugal pump. 1500 w. Eng Rec—Sept. 29, 1906. No. 79557.

Test of a Two-Stage Centrifugal Pump. Illustrated description of the method of testing for capacity and efficiency. 1800 w. Engr, U S A—Oct. 15, 1906. No. 79809 C.

Discharge.

A Device for Regulating the Discharge of Water from a Reservoir. P. Bouéry. Illustrated description of this device, and report of results obtained. 1800 w. Bul Am Inst of Min Engrs—Sept., 1906. No. 79851.

Pumping.

Pumping Plant for the New Graving Dock at Quarry Bay, Hong Kong. Illustrated description of one of the largest electrically-driven plants of its kind. 1800 w. Engr, Lond—Oct. 12, 1906. No. 80061 A.

See also Civil Engineering, Water Supply.

Stream Flow.

See Civil Engineering, Waterways, Measurement.

Turbines.

Standard Notation in Turbine Design (Einheitliche Bezeichnungen im Turbineenbau). Prof. R. Camerer. A discussion of the various plans to determine a uniform notation for the various angles and other elements of hydraulic turbines of the Francis type. Serial. Part 1. 4000 w. Zeitschr f d Gesamte Turbinenwesen—Oct. 10, 1906. No. 79977 D.

Valves.

Valves for High-Speed Pumps (Ventile Raschlaufender Pumpen). Hermann Sturm. Describing the Gutermuth valve of flat rolled spring metal, giving extreme lightness and quick action. 1800 w. Elektrotech u Maschinenbau—Oct. 7, 1906. No. 79968 D.

Water Power.

The Utilization of Water Power (Die Verwertung der Wasserkräfte). MM. Lauda and Goebl. An extended review of the development of the power of streams in central Europe, with examples of important hydro-electric stations. 12000 w. 3 plates. Oesterr Wochenschr f d Oeffent Baudienst—Sept. 22, 1906. No. 79978 D.

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MACHINE WORKS AND FOUNDRIES.

Annealing.

Annealing Under Gas. Walter J. May. Presents the advantages of this method for bright steel work. 800 w. Prac Engr —Sept. 28, 1906. No. 79681 A.

Boiler Works.

The Lake Erie Boiler Works, Buffalo, N. Y. Illustrated detailed description of the works and their equipment. 1400 w. Boiler Maker—Oct., 1906. No. 79724.

Brass Wire.

The Manufacture of Brass Wire. E. J. Bolton. Read before the Graduates Assn. of Inst. of Mech. Engrs. A general description of the methods of manufacture, showing the advantages and disadvantages of various ways of obtaining brass and converting it into wire. 3000 w. Mech Engr—Oct. 20, 1906. No. 80128 A.

Case Hardening.

Some Obscure Points in the Theory of Cementation (Sur Quelques Points Obscures de la Théorie de la Cementation). M. Partiot. A study of the laws which govern the penetrating depth of case hardening operations, together with the action of various cementing materials. 3000 w. Revue de Métallurgie—Sept., 1906. No. 79930 H.

Castings.

A Peculiar Chilled Casting. George C. Davis. Read before the Phila. Found. Assn. Describes the casting, giving illustrations and the method of charging. 700 w. Ir Age—Oct. 11, 1906. No. 79691.

Converter Steel Castings Practice. Arthur Simonson. The first of a series of illustrated articles aiming to give a general idea of the science and art of making steel castings in a foundry equipped with the Tropenas system of steel making. The present number describes the mechanical part of a Tropenas plant. 3000 w. Foundry—Oct., 1906. Serial. 1st part. No. 79743.

Difficult Castings Made by Green Moulders. An illustrated study of the conditions in Milwaukee which shows that even the most difficult castings can be made by unskilled labor with a good foreman. Also editorial. 2500 w. Ir Trd Rev—Oct. 25, 1906. No. 80102.

Semi-Steel Castings. Harry Malone. Explains what this material really is. 400 w. Foundry—Oct., 1906. No. 79741.

The Use of Manganese in Making Brass Castings. M. Palfrey. Discusses the advantages of manganese and some of the difficulties in using it, describing the method of the writer. Ills. 1500 w. Brass Wld—Oct., 1906. No. 80065.

Dies.

Blanking and Piercing Dies for Washers. C. F. Emerson. Diagrams and suggestions for the making of such dies. 1600 w. Mach, N. Y.—Oct., 1906. No. 79613 C.

The Manufacture of an Opening Die by Means of Various Labor-Saving Devices. Illustrated description of methods and tools used in making the Ideal opening die. 1600 w. Am Mach—Vol. 29. No. 40. No. 79616.

Drill Chuck.

The Making of a Drill Chuck. Remarks on the aims and methods of the inventor, describing the operations covering the manufacture. Ills. 2500 w. Am Mach—Vol. 29. No. 42. No. 79829.

Flux.

Fluor Spar as a Flux. Letters for and against the use of fluor spar. 1200 w. Foundry—Oct., 1906. No. 79742.

Foundry.

The Steel Foundry Co., Cincinnati, O. Illustrated description of a new plant near Ivorydale, and its equipment. 1000 w. Foundry—Oct., 1906. No. 79739.

Furnaces.

The Reverberatory Furnace in American Foundries (Der Flammofenbetrieb in Amerikanischen Giessereien). V. Portisch. With plans and details of furnaces of various design and capacity as actually used in American foundries. 2500 w. Stahl u Eisen—Oct. 1, 1906. No. 79940 D.

Gauges.

Notes on Gauges and Measuring Appliances (Note sur quelques Jauges et Calibres). G. Richard. With illustrations of a variety of micrometer and vernier calipers, and a discussion of precise measurements in the shop. 6000 w. Revue de Mécanique—Aug. 31, 1906. No. 79920 E⊤F.

Grading.

Grading Pig Iron for the Foundry. P. Munnoch. Read before the British Found. Assn. Discusses grading by fracture and by analysis, and proposes a system of buying by grade and silicon. 3000 w. Ir Trd Rev—Oct. 25, 1906. No. 80104.

Graduating.

Graduating Range Dials for Navy Guns. J. J. Strong. Describes the method used in the shop of the Washington Navy Yard. Ills. 800 w. Am Mach—Vol. 29. No. 40. No. 79614.

Grinding.

The Cost of Grinding. H. F. Noyes. How to determine the cost of commercial wet grinding is discussed. 1000 w. Mach, N Y—Oct., 1906. No. 79612 C.

Hardening.

Methods and Precautions in Hardening Steel (Ueber Verschiedene Vorsichten und Kunstgriffe beim Härten des Stahles). Prof. F. Kick. A discussion of experimental investigations into the best methods of hardening steels, showing the importance of entrusting this work to a special scientific department for the entire shop. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 1, 1906. No. 79948 D.

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Hydraulic Press.

The Seamless Pressed Steel Bathtub. An illustrated article describing the hydraulic presses employed and the processes used in heavy pressed metal work. 2500 w. Ir Age—Oct. 11, 1906. No. 79690.

McKenna Process.

The English McKenna Process Company, Limited. Especially an illustrated description of the electrically-driven rolling mills of these works, but gives also a résumé of the treatment the rails receive. 2800 w. Elec Engr, Lond—Oct. 5, 1906. Serial. 1st part. No. 79792 A.

Molding.

Molding a Tank—A New Method. H. J. McCaslin. Illustrated description of the method. 800 w. Am Mach—Vol. 29. No. 42. No. 79828.

Polishing.

The Use of Steel Balls in Polishing Metals in the Tumbling Barrel. Explains the theory of this use of the balls, the kind of balls and manner of using them, describing the tumbling barrel and the character of the work that may be tumbled. Ills. 1500 w. Brass Wld—Oct., 1906. No. 80066.

Purchasing.

The Purchase of Materials in a Large Engineering Works. E. T. White. Deals with the purchasing of such goods as the works do not themselves manufacture. 3000 w. Engng—Sept. 21, 1906. Serial. 1st part. No. 79583 A.

Rings.

Formulas for Constructing Rings Made from Square or Flat Iron Bent Edgewise. S. Uren. Read before the Ry. Mas. Blksmiths Assn. Gives the formulas used by the writer which have been proved by actual practice. 900 w. Am Mach—Vol 29. No. 42. No. 79827.

Sand.

The Study of Moulding Sand (Die Untersuchung des Formsandes). Hugo Fürth. Brief notes on the chemical and physical properties of good moulding sand. 1500 w. Stahl u Eisen—Oct. 1, 1906. No. 79944 D.

Screws.

Report of the Committee on Standard Proportions for Machine Screws. Revised report with tables and general discussion. Ills. 9000 w. Pro Am Soc of Mech Engrs—Oct., 1906. No. 79855 C.

Shop Specialties.

Some Specialties of a Baltimore Shop. Illustrates and describes an automatic machine for cooking and filling 40,000 cans of corn a day, rotary pressure blowers, etc. 2200 w. Am Mach—Vol. 29. No. 41. No. 79767.

Shrinkages.

Graphic Representation of the Relation of Pressures and Shrinkages of Built-Up Guns for the States of Action and Rest. Louis M. Multon. Gives diagram and study, aiming to show the coordinate relation of all conditions of the parts of the gun cylinders between the states of action and rest and the limited conditions. Assists in the study of elastic strength. 7500 w. Pro U S Nav Inst—Sept., 1906. No. 79844 F.

Tempering.

A Study of the Tempering of Steel (Etude Sur la Trempe de l'Acier). P. Lejeune. Data and results of a thermal study of the process of tempering, with diagrams giving the resulting curves. 2500 w. Revue de Métallurgie—Sept., 1906. No. 79929 H.

Thread Milling.

Cutter-Head Mechanism of the Thread-Milling Machine. A. E. Tcherniak. Outlines special problems in these machines, giving an analysis and description of their solutions. Ills. 1800 w. Am Mach—Vol. 29. No. 42. No. 79826.

Tool Drives.

Machine Tool Drives. John Edgar. Considers the selection of the form the drive is to take and the amount of power, and the speeds, comparing the results of different methods. 2500 w. Mach, N. Y.—Oct., 1906. No. 79610 C.

Turbine Shop.

Messrs. Richardsons, Westgarth and Co.'s Steam Turbine Department. Illustrated description of this department and its equipment. 2200 w. Elec Rev, Lond—Sept. 28, 1906. No. 79693 A.

Turning.

Note on the Turning of a Crank Shaft (Note sur le Tournage d'un Arbre Coudé). V. Marmor. A graphical study of the forces tending to produce flexure in a solid forged crank shaft during the operation of turning in the lathe. 3500 w. Revue de Mécanique—July 31, 1906. No. 79918 E+F.

Valves.

A Convenient Method of Weighing and Dismantling a Jenkins Back-Pressure Valve. W. H. Wakeman. Illustrates and describes the plan adopted by the writer. 700 w. Power—Nov., 1906. No. 80077 C.

Hot-Pouring vs. Cold-Pouring of Valves. Erwin S. Sperry. Remarks on difficulties due to the pouring temperature. Ills. 6000 w. Brass Wld—Oct., 1906. No. 80067.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Brittleness.

Brittleness in Steel and Fractures in Boiler Plates. C. E. Stromeyer. Abstract. A report of tests, with accounts of cases of fracture and the investigations made. 4000 w. Mech Engr—Oct. 13, 1906. No. 80040 A.

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Cast Iron.

Some Notes on the Chemistry of Cast Iron. L. Houghton. Read before the British Found. Assn. Considers carbon, silicon, manganese and sulphur, and phosphorus. Ills. 3000 w. Ir Trd Rev—Oct. 18, 1906. No. 79822.

Chain Testing.

Denison's Apparatus for Detecting the Overloading of Chains. Illustrates and describes this appliance. 500 w. Mech Engr—Oct. 6, 1906. No. 79791 A.

Fractures.

Fracture of Axles Originating in Drilled Holes. Lucien Alphonse Legros. Calls attention to the risk incurred by drilling holes in axles and shafts, and the importance of examining shafts or axles so drilled with a view to detecting signs of fracture. Ills. 500 w. Inst of Civ Engrs—No. 3582. No. 79520 N.

Steels.

Heat-Treatment of Steels Containing Fifty and Eighty Hundreths Per Cent of Carbon. C. E. Corson. Describes experimental investigations, giving micrographs. 3000 w. Bul Am Inst of Min Engrs—Sept., 1906. No. 79849 D.

The Nickel-Chrome Steels (Aciers Nickel-Chrome). L. Guillet. A general study of the micrographic properties of the nickel chromium group of steels, with data showing their mechanical applications. 4500 w. Revue de Métallurgie—Aug., 1906. No. 79927 H.

The Nickel Silicon Steels (Aciers Nickel-Silicium). L. Guillet. A study of the nickel-silicon alloy steels and their practical applications. 5000 w. Revue de Métallurgie—Oct., 1906. No. 79931 H.

See also Mining and Metallurgy, Iron and Steel.

Tantalum.

Tantalum: Its Ores, Detection, Properties, and Uses. Frank H. Michell, and W. A. Michell. Information concerning this rare metal which, up to the present, is used chiefly for electric lamps. 2500 w. Min Jour—Sept. 29, 1906. No. 79700 A.

White Alloys.

The Strength and Elasticity of White Metal. John Goodman. Reports tests made with the object of ascertaining the physical properties of some white alloys which are used in the construction of pumps required for dealing with acids, alkalies, etc. 1000 w. Engng—Sept. 21, 1906. No. 79582 A.

MEASUREMENT.

Colorimeter.

A New Colorimeter for the Determination of Carbon in Steel. Charles H. White. Illustrated description of an instrument designed for the rapid and accurate application of the method based on the thickness or depth of the portion of the solution examined. 2000 w. Bul Am Inst of Min Engrs—Sept., 1906. No. 79850.

Metallography.

Practical Applications of Microscopic Metallography in the Workshop (Des Applications Pratiques de la Métallographie Microscopique dans les Usines). H. Le Chatelier. Showing the extent to which the microscope may be used in practical metallurgical operations. 6000 w. Revue de Métallurgie—Sept., 1906. No. 79928 H.

Segments.

Curve for Determining Relation between Circle Diameters and Circular Segments. A. V. Youens. Gives curve and examples of its application in determining the area of a segment of a circle. 600 w. Power—Nov., 1906. No. 80076 C.

Standard Measures.

Method of Comparing Standard Measure Bars. Louis A. Fisher. Describes a simple process for deriving the yard from the meter bar. 1800 w. Am Mach—Vol. 29. No. 43. No. 80081.

POWER AND TRANSMISSION.

Bearings.

A New Turbo-Dynamo Bearing. Drawing and description of a high-speed bearing designed by Messrs. Alioth. 350 w. Elec Engr, Lond—Sept. 28, 1906. No. 79689 A.

Compressed Air.

Air Compressing Plants for the North River Tunnels of the Pennsylvania R. R. Frank Richards. Illustrated description of the plants constructed to carry on this great work. 2200 w. Eng Rec—Oct. 13, 1906. No. 79784.

Selection of Proper Air Compressor. Joseph D. Cone. Discusses the economic and mechanical considerations influencing the purchaser. Ills. 3300 w. Mines & Min—Oct., 1906. No. 79628 C.

Vacuum Peculiarities. Edward F. Schaefer. Discusses points in the maintaining of vacuums, the single stage and two-stage compression, etc. 1400 w. Compressed Air—Oct., 1906. No. 79738.

Cranes.

Portable Turntable Cantilever Crane. Illustrated description of an interesting type built at Duisburger, Germany. 900 w. Engr, Lond—Sept. 28, 1906. No. 79713 A.

The Electric Crane in the Foundry. Harry Sawyer. Read at the A. F. A. Convention. Gives facts of interest in relation to the development and use of electric cranes in foundries, the types, and designs. 2500 w. Foundry—Oct., 1906. No. 79740.

Electric Driving.

Electricity in Steel Works. An illustrated article showing the adaptability of the electric motor for the motive-power requirements of such works, especially the

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driving of live rolls. 2000 w. Elec Rec, Lond—Oct. 12, 1906. No. 80046 A.

Interesting Application of Motors to Existing Machine Tools. Illustrates and describes applications made in a Brooklyn factory where individual motor drive is employed. 3000 w. Elec Wld—Oct. 20, 1906. No. 80020.

Power Plant of the Western Banknote and Engraving Co. Illustrates and describes a modern motor-driven engraving plant. 1500 w. Engr, U S A—Oct. 1, 1906. No. 79597 C.

Some Economical Aspects of the Electric Drive. F. M. Feiker. Considers some of the benefits accruing from the installation of the electric motor drive in a factory. Ills. 1500 w. Cassier's Mag—Oct., 1906. No. 79529 B.

Elevators.

Electric Passenger-Lifts for the Baker Street and Waterloo Railway. Illustrated detailed description of the elevators for this and other underground railways in England. Plate. 4800 w. Engng—Sept. 21, 1906. No. 79584 A.

Exposition.

Power Machinery at the Reichenberg Exposition (Die Kraftmaschinen der Reichenberger Ausstellung). Karl Rubricius. A brief notice of the steam engines, boilers, turbines, and combustion motors shown at the German-Bohemian exposition at Reichenberg. 2000 w. Elektrotech u Maschinenbau—Sept. 23, 1906. No. 79963 D.

The Prime Movers at the German-Bohemian Exposition at Reichenberg (Die Kraftmaschinen auf der Deutschböhmischen Ausstellung in Reichenberg). K. Körner. With illustrations and details of the steam engines and other prime movers at the Bohemian exposition. Serial. Part 1. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 15, 1906. No. 79900 D.

Prime Movers of the Bavarian National Exposition at Nuremberg (Kraftmaschinen auf der Bayerischen Landesausstellung in Nürmberg). H. Dubbel. Illustrating and describing numerous steam engines, boilers, turbines, and other power machinery exhibited. Serial. Part 1. 3500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Sept. 29, 1906. No. 79902 D.

Gas Transmission.

A Proposition to Generate Gas on a Large Scale at Coal Mines and Transmit it Under Pressure for Light, Heat and Power. Summary of papers by Arthur J. Martin, on the long distance transmission of gas, presented before meetings of British Scientists. 1200 w. Eng News—Oct. 4, 1906. No. 79623.

Gears.

Spiral Gears. H. B. McCabe. Discusses how to make the calculations and cut the gears, giving diagrams, and formulas. 1200 w. Am Mach. Vol. 29. No. 41. Serial. 1st part. No. 79766.

Power Plant.

Mechanical Equipment of the Carnegie Library Building Extension, Pittsburg, Pa. View and plans of the building, with description of a plant involving electrical generating, heating and ventilating, refrigerating, elevator, vacuum sweeping, and air compressing apparatus, all of large capacity. 2800 w. Eng Rec—Oct. 20, 1906. Serial. 1st part. No. 79886.

The Planning and Construction of the Power Plant. A. E. Dixon. The fourth paper treats of the practical phenomena of combustion, including the relative merits of natural and mechanical draft, combustion rates, etc. 4000 w. Engineering Magazine—Nov., 1906. No. 79996 B.

The Power Plant of the Pittsburg Terminal Warehouse and Transfer Co. Briefly outlines the requirements of this extensive terminal warehouse, and illustrates and describes the power plant which is designed to serve it. 4000 w. Eng Rec—Sept. 29, 1906. No. 79556.

Power Problem.

The Industrial Power Problem. W. B. Esson. Address to the Civil and Mech. Engrs. Soc., slightly condensed. Deals with cases where the power production is dependent upon some form of fuel, discussing its production and distribution, cost, etc. 3000 w. Mech. Engr—Oct. 13, 1906. Serial. 1st part. No. 80042 A

Shafts.

Continuous Beams or Shafts Having Three Supports. E. Wagner. Gives a table for use in determining the dimensions of a shaft having three supports, and formulas by means of which exact values may be found for conditions not specified in the table. 1000 w. Eng News—Oct. 11, 1906. No. 79718.

Sheaves.

Sheaves for Wire Rope (Ueber Drahtseilscheiben). Siegfried Abt. Discussing the advantages of using some form of friction filling in the grooves of rope sheaves; comparing the relative value of wood, leather, and metallic fillings. 2000 w. Schweiz Bauzeitung—Sept. 15, 1906. No. 79971 B.

STEAM ENGINEERING.

Boilers.

Boiler Horse-Power. N. A. Carle. Gives charts which enable one to find without calculation the horse-power developed and the evaporation necessary to generate a given horse-power. 1000 w. Power—Nov., 1906. No. 80078 C.

Note on the Tightness of Foundation Rings. O. Busse. Considers the foundation rings in connection with locomo-

tive boilers, showing that double-riveting is a disadvantage as regards tightness, and recommends a single row of rivets and deepened at the corners, the outer shell being fixed to the ring at those points, by about eight rivets. 900 w. Bul Int Ry Cong—Sept., 1906. No. 79889 E.

Notes on the Working of Water-tube Boilers. R. Somerville Bayntun. Gives the writer's experience with various types of water-tube boilers, describing tests which proved of value in keeping the boilers in good condition. 1800 w. Elec Rev, Lond—Oct. 12, 1906. No. 80047 A.

Breakdowns.

Engine Breakdowns and Their Lessons. Michael Longridge. Abstract of report of the chief engineer in the British Engine, Boiler, and Electrical Insurance Co., Ltd., for the year 1905. 4000 w. Mech Engr—Sept. 29, 1906. Serial. 1st part. No. 79683 A.

Combustion.

An Improved Automatic Recording Gas Tester. [Ein Neuer Selbstregistriender Gasprüfer). S. Bourdot. Illustrating an improved recorder for showing the proportion of carbon dioxide in the flue gases from boiler furnaces, etc. 1800 w. Elektrotech u Maschinenbau—Sept. 30, 1906. No. 79966 D.

Engines.

The Influence of Moving Masses in the Steam Engine. (De l'Influence des Masses en Mouvement dans la Machine à Vapeur). A. Bauermeister. A study of the inertia action of the reciprocating parts and of the fly wheel for simple and compound engines. 6000 w. Revue de Mécanique—Aug. 31, 1906. No. 79919 E+F.

Thermal Phenomena in Steam Engines. (Les Phénomènes Thermiques dans les Machines à Vapeur). Armand Duchesne. Discussing experiments upon the heat interchanges in the cylinder walls. The temperatures were measured by imbedded thermo-electric couples. 12000 w. Revue de Mécanique—July 31, 1906. No. 79916 E+F.

Reciprocating Steam Engines vs. Steam Turbines. W. P. Hancock. Gives a comparison of operation between two power houses of modern type. 4500 w. Cassier's Mag—Oct., 1906. No. 79524 B.

Relative Economy of Turbines and Engines at Varying Percentages of Rating. Walter Goodenough. Read before the Am. St. & Int. Ry. Engng. Assn. Considers the economy in operation of individual units and also economy in their selection as affected by type and design. 3000 w. Eng Rec—Oct. 20, 1906. No. 79883.

Feed-Water.

Feed-Water Heating. R. T. Strohm. Discusses the economy, safety and value of feed-water heating, and considers feed-water heaters. 2000 w. Elec Wld—Oct. 6, 1906. No. 79678.

Fuels.

Fuel Analysis for Steam Users. John B. C. Kershaw. Considers the sampling and the preparing of the sample, the analysis, etc., illustrating apparatus used. 4800 w. Engr, Lond—Sept. 28, 1906. Serial. 1st part. No. 79711 A.

Gaseous Fuels. Oskar Nagel. Translated from Baron Hanns Jüptuer von Jonstorff's Chemical Technology of Energies. Considers the methods of production of gaseous fuels, their composition, etc. 4000 w. Elec Chem & Met Ind—Oct., 1906. No. 79658 C.

Some Characteristics of Coal as Affecting Performance with Steam Boilers. W. L. Abbott. Gives results and conclusions from the report of Mr. Bement in regard to tests made by the Chicago Edison Company. General discussion. 15500 w. Jour W Soc of Engrs—Oct., 1906. No. 80006 D.

The Burning of Washer Slate and Coke Braize. C. G. Atwater. Reports the writer's experience with this low-grade fuel. The results were excellent and showed a saving of $43 per day over coal under former conditions. Ills. 2500 w. Elec Wld—Oct. 6, 1906. No. 79677.

Governors.

Electro-Magnetic Control of Governors. Harry R. Speyer. Describes a method of keeping the voltage constant by use of an electro-magnetic coil attached to one end of the lever of the engine governor. Ills. 1000 w. Elec Rev, Lond—Oct. 5, 1906. No. 79794 A.

The Inertia Governor. I. A Study of the Inertia Fly-Wheel Governor. H. A. Swanton. II. Adjusting the Rites Inertia Governor. R. E. Cahill and S. H. Bunnell. Articles from the analytical and operative standpoints. Considers the principles involved and how to apply them. Ills. 4400 w. Power—Nov., 1906. No. 80075 C.

Injectors.

High Pressure Steam Tests of an Injector. Strickland L. Kneass. Reports a series of tests of the instrument known as the Improved Self-acting Injector, Size No. 10½, showing an unusually efficient injector through a wide range of conditions. Ills. 2200 w. Jour Fr Inst—Oct., 1906. No. 79729 D.

Lubrication.

Methods of Internal Lubrication. Robert R. Keith. An illustrated article showing how methods of lubrication were improved to keep pace with engine development. 2500 w. Engr, U S A—Oct. 15, 1906. No. 79808 C.

Pipe Coverings.

Recent Calorimetric Investigations

We supply copies of these articles. See page 479.

upon Heat Insulating Materials (Neuere Kalorimetrische Untersuchungen von Wärmeschutz mitteln). H. Benisch and A. Anderson. Instead of steam the pipes were filled with air heated by electric currents, the rates of transmission through various coverings being determined in calories per square metre of surface. 3000 w. Zeitschr d Ver Deutschr Ing—Oct. 13, 1906. No. 79908 D.

Steam Turbines.

Notes on the Steam Turbine (Mitteilungen über Dampfturbinen). A. Rateau. Illustrating and describing the development of the Rateau turbine, and of the Rateau multicellular pressure blower. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—Sept. 15, 22, 1906. No. 79901 each D.

Some Considerations on the Double-Flow Turbine. Remarks on the advantages and characteristics of this type of steam turbine. 1500 w. Elec Rev, Lond—Oct. 12, 1906. No. 80048 A.

Steam Turbines at the Nurnberg Exhibition. Illustrated description of interesting examples shown at the Bavarian Territorial Exhibition. 1000 w. Engr, Lond—Oct. 19, 1906. No. 80146 A.

The Compound-Reaction Steam-Turbine. Begins a study of this type of turbine, its losses, working, etc. Ills. 2200 w. Engng—Oct. 19, 1906. Serial. 1st part. No. 80138 A.

Superheating.

Superheated Steam. E. H. Foster. Read before the N. A. S. E. Considers types of superheaters, and the use of superheat as an economy with different types of engines. 2000 w. Engr, U S A—Oct. 15, 1906. No. 79810 C.

Superheated Steam in the Power Station. Arthur S. Mann. Relates some of the experiences met in a plant of 1800 boiler horse power, generating steam of 185 pounds pressure and 200 degrees F. superheat. 2000 w. Jour Fr Inst—Oct., 1906. No. 79730 D.

The Influence of Highly Superheated Steam upon Lubrication and the Deformation of the Valve Gear (Influence de la Vapeur à Haute Surchauffe sur le Graissage et la Déformation des Distributions). A. Bauermeister. With data concerning the behavior of lubricants at high temperatures, together with a comparison of Corliss, poppet and piston valves for use with superheated steam. 4000 w. Revue de Mécanique—Sept. 30, 1906. No. 79921 E+F.

MISCELLANY.

Aeronautics.

Results of the First International Balloon Race. An interesting account of the Aeronautic Cup contest for spherical balloons. 1500 w. Sci Am—Oct. 13, 1906. No. 79753.

The First International Balloon Race. An illustrated account of the race for the cup offered by James Gordon Bennett. 1600 w. Sci Am—Oct. 27, 1906. No. 80093.

Exhibition.

The Engineering and Machinery Exhibition, Olympia. Joseph Horner. Illustrates and describes some of the interesting exhibits. 4500 w. Engng—Sept. 21, 1906. Serial. 1st part. No. 79587 A.

Mechanics.

On Equimomental Systems and Their Use in Applied Mechanics. R. F. Muirhead. Gives some simple systems of points which are equimomental with the most commonly occurring types of bodies and areas, pointing out some advantages of their use in practical calculations. Discussion. 4800 w. Trans of Inst of Engrs & Shipbldrs—May 1, 1906. No. 79758 D.

MINING AND METALLURGY

COAL AND COKE.

Classification.

The Classification of Coals. S. W. Parr. Read before the Am. Chem. Soc. Outlines a plan of classification proposed, discussing its new features. 2000 w. Min Rept—Oct. 18, 1906. No. 80026.

Coke Ovens.

Coke Oven Construction. W. M. Judd. Gives a brief description of the "beehive" type of oven as constructed at the present time, with illustrations. Also discussion. 9000 w. Pro Engrs' Soc of W Penn—Oct., 1906. No. 80097 D.

The Koppers Coke Oven System (Ueber Koksofenanlagen System Koppers). H. Herbst. Illustrating an improved form of regenerative by-product coke oven, with complete details of construction and operation. 4000 w. Glückauf—Oct. 6, 1906. No. 79936 B.

Consolidation.

Consolidation of Five Large Coal Mines. J. Leggett Pultz. An illustrated account of a consolidation formed in the Pittsburg gas-coal district. 1500 w. Eng & Min Jour—Oct. 6, 1906. No. 79665.

English Collieries.

Some Modern English Collieries. Brief descriptions of interesting collieries visited by the American Mining Engineers recently. 2500 w. Engr, Lond—Oct. 19, 1906. No. 80147 A.

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Improvements.

Improvements in Operating Plant in the Rhenish-Westphalian Coal Mining District in 1905 (Neuanlagen im Betriebe der Rheinisch-Westfälischen Steinkohlengruben, 1905). E. Wex. A classified report of improvements in motive power, lighting, and machinery in the various mines of the Westphalian district. Serial. Part I. 4500 w. Glückauf—Oct. 13, 1906. No. 79938 B.

Lignite.

Lignite Briquets. Elwyn Waller and H. Stanley Renaud. Illustrates and describes a system for the utilization of low-grade coal. 3500 w. Eng & Min Jour—Oct. 6, 1906. No. 79664.

The Lignite Coals of North Dakota. Frank Alonzo Wilder. Describes these deposits and gives a report of trial boiler tests, and of producer gas test. 2500 w. Ec Geol—July, 1906. No. 79840 D.

Maryland.

Mining in the George's Creek Coalfield. F. W. Parsons. Gives briefly the history, describing the conditions and methods employed. 3500 w. Eng & Min Jour—Oct. 13, 1906. No. 79778.

Pocahontas.

The Pocahontas Collieries Company. F. W. Parsons and William Leckie. An illustrated account giving the system of mining adopted for a monster vein of coal. 2500 w. Eng & Min Jour—Oct. 27, 1906. No. 80107.

Queensland.

The Coal Measures Near Townsville. Lionel C. Ball. A report of an examination made of this district in Queensland and the results. 3500 w. Queens Gov Min Jour—Aug. 15, 1906. No. 79580 B.

Submarine Mines.

Submarine Coal Mining. Richard H. Brown. Read before the Min. Soc. of Nova Scotia. Describes the operations of a colliery on Cape Breton Island, working under water. 1600 w. Aust Min Stand—Sept. 19, 1906. No. 80122 B.

COPPER.

Concentration.

Concentration Methods at the Old Dominion, Globe, Arizona. H. J. Baron. Plan and description of the 500-ton capacity copper concentration plant, and the methods employed. 1100 w. Min Rept—Oct. 4, 1906. No. 79650.

La Cananea.

La Cananea Mining Camp. Dwight E. Woodbridge. Illustrates and describes the mines, mills and smelter, the methods, development and interesting features of this copper mining property in Mexico. 3000 w. Eng & Min Jour—Oct. 6, 1906. No. 79659.

Lake Superior.

Lake Superior Copper. Horace J. Stevens. A report of the Lake Superior copper industry and the great amount of development work under way. 1700 w. Min Jour—Oct. 20, 1906. No. 80137 A.

Ore Breaking at Lake Superior. W. R. Crane. An illustrated description of the methods employed in the copper mines. 2800 w. Eng & Min Jour—Oct. 27, 1906. No. 80105.

The Calumet & Hecla Company's Properties. The first of a series of illustrated articles on this prominent copper district, reviewing the past, discussing the present and the future outlook. 1600 w. Min Wld—Oct. 13, 1906. Serial. 1st part. No. 79764.

Mexico.

Los Pilares Mine, Nacozari, Mexico. Samuel Franklin Emmons. A geological study of this copper mine and its deposits, giving its location. Ills. 5000 w. Ec Geol—July, 1906. No. 79836 D.

Nevada.

Ely, Nev., and Its Copper Properties. Col. W. A. Root. Information of this region and the companies operating. Ills. 1300 w. Min Wld—Sept. 29, 1906. No. 79567.

Ore Deposits.

Sketch of the Geology and Ore Deposits of the Cochise Mining District, Cochise County, Arizona. L. O. Kellogg. An account of this district and its ores of copper minerals and wolframite. 3000 w. Ec Geol—July, 1906. No. 79838 D.

Refining.

Cowper-Coles Centrifugal Process. J. B. Van Brussel. A novel electrolytic process for the simultaneous refining of copper and shaping the finished product. Ills. 1600 w. Mines & Min—Oct., 1906. No. 79629 C.

The Knorr Method of Determining Arsenic and Antimony in Refined Copper. P. Butler. An explanation of this method. 700 w. Can Min Rev—Oct., 1906. No. 80016 B.

Smelting.

The Kiddie Hot-Blast System for Copper-Smelting Furnaces. E. Jacobs. Illustrated description of this system and its application at the Tyee Copper Company's smelting works. 2500 w. Eng & Min Jour—Sept. 29, 1906. No. 79552.

GOLD AND SILVER.

Ancient Mines.

A Historic Mine. An account of the Salida gold and silver mines of Sumatra, which are to be worked by modern methods. Ills. 3000 w. Min Jour—Oct. 20, 1906. No. 80136 A.

Black Sands.

Treatment of Auriferous Black Sands. Information concerning experiments in Otago and Southland. Also report by Kenneth Ross, on "Some Experiments on the West Coast." 4000 w. N Z Mines Rec—Aug. 16, 1906. No. 80123 B.

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Cobalt.

Cobalt. J. A. Macdonald. A report of conditions at these Ontario mines, and a discussion of the outlook. 1500 w. Min & Sci Pr—Oct. 13, 1906. No. 80015.

The Cobalt Mining District. Dr. Robert Bell. From the Summary Report of the Geological Survey Department of Canada for 1905. Describes this district and its ore deposits, giving notes on some of the mines. 7500 w. Can Min Rev—Oct., 1906. No. 80018 B.

Concentration.

Mills and Milling Practices at Creede, Colorado. Describes the four milling plants of the successive wet-crushing concentration system for low-grade gold and silver ores. Ills. 2500 w. Min Rept—Oct. 4, 1906. No. 79651.

Distribution.

The Geological Distribution of Gold. T. A. Rickard. Read before the Am. Min. Con. Reviews some of the blunders that delayed the discovery of highly productive mining regions, showing that gold occurs in rocks of every age and every kind. 3300 w. Min Rept—Oct. 28, 1906. No. 80121.

Frozen Gravel.

Frozen Gold Gravel. J. P. Hutchins. Illustrated description of phenomena observed in the frozen ground of the far north, and the methods used in breaking and thawing it preparatory to recovering its gold contents, suggesting improvements. 2500 w. Eng & Min Jour—Oct. 20, 1906. No. 79874.

Kalgoorlie.

Gold Stealing in Kalgoorlie. Ralph Stokes. Discusses the estimate of the amount stolen, and the little that is done to prevent such theft. 1200 w. Min Wld—Sept. 29, 1906. No. 79569.

Madagascar.

Some Gold Vein Formations of Madagascar. Mr. Dégoutin. Describes the deposits thus far explored, and their peculiarities. 3500 w. Min Jour—Sept. 22, 1906. No. 79581 A.

Mexico.

The Mining Camps of Sinaloa, Mexico. F. J. H. Merrill. An illustrated account of these mines which yield principally silver, though in some gold predominates. 900 w. Eng & Min Jour—Oct. 6, 1906. No. 79663.

The Copete District, Central Sonora. F. J. H. Merrill. Illustrates and describes the La Sultana gold mine, its geology, ore-bodies, and other mines of this district. 700 w. Eng & Min Jour—Oct. 6, 1906. No. 79660.

The Sahuaripa District, Sonora, Mexico. C. Nelson Nelson. Describes the mining conditions of these promising gold and copper mines. Ills. 2000 w. Eng & Min Jour—Oct. 6, 1906. No. 79661.

Milling.

Mills and Milling Practices in the Silverton Camp, San Juan County, Colorado. H. J. Baron. The ores are gold and silver bearing quartz, with other minerals. Illustrates and describes the improved milling methods for low-grade ores. 2500 w. Min Rept—Oct. 18, 1906. No. 80023.

Nevada.

Gold and Silver at Fairview, Nev. Claude T. Rice. Illustrates and describes a new camp discovered this year, and its workings. 1500 w. Eng & Min Jour—Oct. 20, 1906. No. 79875.

The Manhattan Mining District, Nevada. Claude T. Rice. Illustrated description with general information of present conditions, the development, ore, etc. 2000 w. Eng & Min Jour—Sept. 29, 1906. No. 79549.

New Mexico.

The Cooney District, New Mexico. Blakely Graham. Reports the geology and mining developments of ores, of gold, silver and copper. 1600 w. Eng & Min Jour—Oct. 20, 1906. No. 79876.

Ore Deposition.

Experiments on the Solution, Transportation and Deposition of Copper, Silver, and Gold. H. N. Stokes. Gives preliminary results of experimental investigations carried out in the laboratory of the U. S. Geol. Survey. 2500 w. Ec Geol—July, 1906. No. 79837 D.

Ore Treatment.

Ore Treatment at the Combination Mine, Goldfield, Nevada. Francis L. Bosqui. An illustrated account of this interesting gold producer and its metallurgical problems. 1600 w. Min & Sci Pr—Oct. 6, 1906. Serial. 1st part. No. 79765.

Placers.

Cape Nome Placers. E. B. Wilson. Describes the peculiar occurrence of the gold, and the mining conditions. Ills. 1000 w. Eng & Min Jour—Oct. 13, 1906. No. 79776.

Placers of Santa Fé County, New Mexico. Fayette A. Jones. Briefly reviews the history of this region. 1000 w. Min Wld—Oct. 6, 1906. No. 79648.

Precipitation.

Treatment of the Precipitate and Manipulation of the Tilting Furnaces at the Redjang Lebong Mine, Sumatra. S. J. Truscott. Describes the working of the precipitation plant, giving results and costs. 1500 w. Inst of Min & Met—Oct. 18, 1906. No. 80071 N.

Prospecting.

Prospecting Dredging Ground. D'Arcy Weatherbe. Discusses points to be taken into account beside the actual gold content, and the methods of determining them. Ills. 3000 w. Min & Sci Pr—Oct. 20, 1906. No. 80152.

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Rand.

Rand Metallurgical Practice and Recent Innovations. G. A. and H. S. Denny's paper is discussed. 4500 w. Jour S African Assn of Engrs—Aug., 1906. No. 79571 F.

Sand Sampling.

Sand Sampling in Cyanide Works. Duncan Simpson. States methods employed, with brief discussion of each. 3000 w. Inst of Min & Met—Oct. 18, 1906. No. 80070 N.

Siberia.

Gold Mining in Western Siberia. L. Tovey. Gives statistics of this industry, the conditions and methods of work, milling, etc. Ills. 2500 w. Eng & Min Jour—Sept. 29, 1906. No. 79548.

Smelting.

The New Smelting. Alfred W. Dyer. An account of the introduction of the Huntington-Heberlein process at Nelson, B. C., and the system employed at the Hall Mines Smelter. Ills. 1600 w. Can Min Rev—Oct., 1906. No. 80017 B.

IRON AND STEEL.

Blast Furnace.

The Application of an Acid Hearth to a Blast Furnace (Anwendung von Sauren Böden beim Hochofen). A brief illustrated account of the removal of a basic hearth and replacement with one of acid fire brick. 900 w. Stahl u Eisen—Oct. 1, 1906. No. 79943 D.

Exposition.

The Iron Industry at the Bavarian National Exposition (Die Eisenindustrie auf der Bayrischen Landesausstellung). With plan of the buildings and a general review of the exhibits related to the iron and steel industries. 3500 w. Stahl u Eisen—Oct. 1, 1906. No. 79941 D.

Iron Ores.

Origin and Occurrence of Certain Iron Ores of North-Eastern Kentucky. W. C. Phalen. Describes these deposits and presents hypotheses to account for them. 4700 w. Ec Geol—July, 1906. No. 79839 D.

The Iron Ore Supplies of the Asturias. Map, with description of deposits and their location, development, etc., so far as explored. 5400 w. Ir & Coal Trds Rev—Sept. 28, 1906. No. 79709 A.

Mixers.

Heated Mixers for Pig Iron (Ueber Heizbare Roheisenmischer). O. Simmersbach. With illustrations of several designs of oscillating mixers, so arranged that the contents can be heated during the operation. 3000 w. Stahl u Eisen—Oct. 15, 1906. No. 79945 D.

Rolling Mills.

An Improved Process for Rolling Round Iron (Neues Verfahren zum Walzen von Rundeisen aus Führung). W. Gafel. The rolls are arranged alternately horizontal and vertical, in order to make a truer product. 3500 w. Stahl u Eisen—Oct. 15, 1906. No. 79946 D.

Segregation.

Segregation in Steel Ingots. J. E. Stead. Read before the British Assn. for the Adv. of Science. Gives a summary of conclusions from experimental researches, considering the effects on the mechanical properties of steel. 3000 w. Ir Age—Oct. 18, 1906. No. 79824.

Smelting.

The Blast Furnace and Open Hearth Furnace Combined. Horace Allen. Discusses the present methods of smelting iron and their cost, and illustrates a combined shaft furnace and open hearth furnace as a possible means of securing economy. 900 w. Mech Engr—Sept. 29, 1906. No. 79682 A.

Steel.

Annealing and Crystallization of Steel. Jas. H. Baker. An illustrated article dealing with steel for hard service. 1000 w. Ir Age—Oct. 4, 1906. No. 79609.

Methods of Producing Steel (Die Herstellungsarten des Stahles). W. Schmiedhammer. A review of the various modern steel processes and their commercial applications. Two articles. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 22, 29, 1906. No. 79934 each D.

The Use of Vanadium in Steel Manufacture. B. E. D. Stafford. Read before the Am. Boiler Mfrs. Assn. Gives information concerning results obtained by the use of vanadium, especially its influence in increasing the elastic limit. 1800 w. Am Mech—Vol. 29. No. 41. No. 79768.

See also Mechanical Engineering, Materials.

MINING.

Alaska.

Progress of Investigation of Mineral Resources of Alaska in 1905. Alfred Brooks. Abstract from Bul. of U. S. G. S. Interesting review of the mining industry, the output, the improved conditions, commercial advancement, etc. 2200 w. Min Rept—Oct. 11, 1906. No. 79788.

Blasting.

Detonating Caps for Blasting. Roland L. Oliver. A practical discussion of the principles of the detonation of powder; how blasting caps should be used to secure the most economical results, and the importance of their function. Ills. 5000 w. Eng & Min Jour—Oct. 13, 1906. No. 79777.

Boreholes.

A New Borehole Surveying Instrument. E. H. V. Melvill. Describes an instrument invented by Messrs. Lewis and Francks. Ills. 2500 w. Jour S Africa Assn of Engrs—Aug., 1906. No. 79570 F.

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The Development of the Stratameter (Die Entwicklung der Stratameter). F. Freise. Describing improved apparatus for examining the stratification of underground strata by various forms of core drills. Serial. Part 1. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 13, 1906. No. 79935 D.

Dewatering.

The Fitzgerald Dewatering Screen. H. J. Baron. Drawing and description of a mechanism which has been in satisfactory use for three years for removing water from jig tailings. 500 w. Min Rept—Sept. 27, 1906. No. 79563.

Drainage.

Electric Mine Drainage Plant. Frank C. Perkins. Brief illustrated description of the electrically operated drainage plant installed by the Delaware, Lackawanna & Western Anthracite mine. 1000 w. Min Wld—Sept. 29, 1906. No. 79568.

Tests of the Drainage Plant of the Fransisca Mine at Witten (Versuche an der Wasserhaltung der Zeche Franziska in Witten). Report of the trials of the electric pumping plant of a mine in the Westphalia district, including tests of boilers, engines, dynamos, and pumps. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 29, 1906. No. 79903 D.

Drilling.

Rock Drilling. W. A. T. Davies. Read before the Aust. Inst. of Min. Engrs. Discusses the selection of drills, method of rigging, working, etc. 2800 w. Aust Min Stand—Aug. 29, 1906. Serial. 1st part. No. 79595 B.

Electric Power.

Electrical Installation at the Wilhelmina Mine, Heerlen, Holland. W. Philippi. Describes the driving of centrifugal pumps by electricity. Abstract translation from the *Elektrotechnische Zeitschrift.* 1200 w. Elect'n, Lond—Oct. 12, 1906. No. 80051 A.

Electric Installation at the Bowhill Coal Company's Cardenden Pits. Illustrated description of the equipment for driving haulages, pumps, fans, and other power-using appliances. 1500 w. Col Guard—Oct. 12, 1906. No. 80053 A.

Electricity in Scottish Collieries. Information concerning the electrically-equipped collieries in Scotland. 1800 w. Elec Rev, Lond—Sept. 28, 1906. No. 79694 A.

Firedamp.

A New Apparatus for the Control of Firedamp (Ueber einen Neuen Apparat zur Kontrolle der Grubenbewetterung). H. Breyhahn. The apparatus consists of a pair of counter balancing gas holders, enabling the changes in motion and condition of the mine atmosphere to be recorded on a moving paper diagram. 3000 w. Glückauf—Oct. 13, 1906. No. 79939 B

Gassing. E. A. Mann. Deals with the cause and prevention of the ill effects due to the inhalation of noxious fumes by miners. 3000 w. Aust Min Stand—Sept. 26, 1906. Serial. 1st part. No. 80150 B.

The Ignition of Firedamp by Electric Sparks (Recherches sur l'Inflammation Electrique des Mélanges Explosifs d'Air et de Grisou). MM. H. Couriot and J. Meunier. A study of the explosive character of mixtures of air and firedamp, with regard to the use of electric machinery in collieries. Serial. Part 1. 3000 w. Génie Civil—Oct. 6, 1906. No. 79913 D.

Hard Ground.

Mining Hard Ground. W. A. T. Davies. Abstract of a paper on "The Science of Economically Mining Hard Ground with Percussive Rock Drills and Compressed Air," given in the *Transactions* of the Australasian Inst. of Min. Engrs. Describes methods of working. 3000 w. Eng & Min Jour—Oct. 27, 1906. No. 80106.

Lake Superior.

Drifting and Stoping at Lake Superior. W. R. Crane. An analytical discussion of the methods and costs. 1600 w. Eng & Min Jour—Oct. 6, 1906. No. 79666.

Underground Ore Handling at Lake Superior. W. R. Crane. A practical discussion of the methods at Wolverine and Mohawk mines, describing a new system of tramming. Ills. 2000 w. Eng & Min Jour—Oct. 13, 1906. No. 79779.

Lime-Roasting.

The Lime-Roasting of Galena. W. R. Ingalls. Reviews the changes developed by the new processes for the desulphurization of lead, and points out the differences among the three lime-roasting processes that are in practical use. 8500 w. Bul Am Inst of Min Engrs—Sept., 1906. No. 79848 C.

Mine Cars.

A Revolvable Car Dump. Erskine Ramsay. Illustrated description of a new device for unloading trains of mine cars at one operation. 2000 w. Eng & Min Jour—Oct. 20, 1906. No. 79877.

Mine Development.

Developing a Prospect. Arthur Lakes. Discusses mistakes, difficulties and conditions encountered. Ills. 1700 w. Min & Sci Pr—Sept. 22, 1906. No. 79541.

Mining Laws.

Amendments Advisable to State Laws Affecting Mining Operations. Wilson S. Snyder. Read before the Am. Min. Cong. Discusses the changes desirable, and the means of attaining them. 1700 w. Min Rept—Oct. 25, 1906. No. 80119.

Nevada.

The Mines and Prospects of Searchlight District, Nevada. W. A. Root. An

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illustrated article describing the producing properties of this district. 2000 w. Min Wld—Oct. 20, 1906. No. 80012.

Ore Dressing.

Removal of Wood in Ore Dressing. A. H. Wethey. Explains the trouble caused by the presence of wood, and illustrates and describes a wood-separating device, not patented. 1000 w. Eng & Min Jour—Oct. 20, 1906. No. 79879.

Pumps.

Electrical Mine Pumps at the Ward Shaft, Virginia City. Leon M. Hall. Brief illustrated description of probably the largest electrically-driven mine pumping installation yet constructed. 1000 w. Eng Rec—Oct. 13, 1906. No. 79781.

Pyrites.

Davis Pyrites Mine, Massachusetts. J. J. Rutledge. Gives the location, physiography and geology of the region, describing the deposit and the methods of mining. Ills. 3800 w. Eng &Min Jour—Oct. 13, 1906. Serial. 1st part. No. 79774.

Rescue Apparatus.

A New Respiratory Apparatus for Use in Fires and Mines. Illustrated description of the Chapin-Sherman apparatus. 1200 w. Sci Am Sup—Oct. 27, 1906. No. 80096.

Shafts.

An Elliptical Concrete Shaft Lining at Bridgeport, Pennsylvania. An illustrated article discussing the considerations affecting its choice, the construction and mine-connections. 2500 w. Mines & Min—Oct., 1906. No. 79630 C.

Shaft-Sinking at the Wolverine Mine. W. R. Crane. Illustrates and describes details of a method of advancing a slope shaft without interfering with the regular mining operations. 1600 w. Eng & Min Jour—Oct. 20, 1906. No. 79878.

Shaft-Sinking With Small Machines. Arthur B. Foote. Brief illustrated description of methods used in sinking an incline-shaft for the North Star Mines Co. 800 w. Min & Sci Pr—Oct. 13, 1906. No. 80014.

Wet Sinking in Arizona. R. B. Brinsmade. An account of the heavy flows of water encountered, the methods of excavation, handling pumping and hoisting machinery. Ills. 3000 w. Mines & Min—Oct., 1906. No. 79627 C.

Sketching.

Sketching the Geological Features of a Mine. Prof. Arthur Lakes. Showing the value of sketches in giving a clear understanding of mine formations. 800 w. Mines & Min—Oct., 1906. No. 79631 C.

Transbaikalia.

Prospecting in Transbaikalia. R. Farina. Read before the Inst. of Min. & Met. Information concerning this region which has long been famous for its placer gold mines. 1500 w. Engr, Lond—Sept. 21, 1906. No. 79593 A.

Water Supply.

The Savage River Pumping Plant. Illustrates and describes a plant built to furnish water for a coal mine near Frostburg, Md. 1500 w. Eng & Min Jour—Sept. 29, 1906. No. 79551.

Winding.

Electric Winding Engines. Paul Habets, in a communication to the *Société de l'Industrie Minerale*, gives results obtained from the use of electricity for winding on the Continent. 3500 w. Col Guard—Sept. 28, 1906. No. 79702 A.

The Siemens-Ilgner System of Electrical Mining Hoists. J. W. H. Hamilton. Illustrated detailed description of this system which is characterized by the fly-wheel converter. 2500 w. Eng & Min Jour—Sept. 29, 1906. No. 79550.

The Steam Consumption of Modern Winding Engines. Describes a cross-compound Corliss winding engine at a colliery in Nottinghamshire, calculating its steam consumption. 1800 w. Engr, Lond—Oct. 12, 1906. No. 80059 A.

MISCELLANY.

Analysis.

A System of Qualitative Analysis for the Common Elements. Arthur A. Noyes and William C. Bray. Gives an outline of the investigation, describing in detail the procedures, explaining the preparation of the solution, and the analysis of silver, copper, and tin groups. 41000 w. Tech Qr—Sept., 1906. No. 80000 E.

Borax.

Borax Mining in California. Day Allen Willey. Describes the surface mining in the Mojave desert, and its replacement by underground mining, the methods used and the treatment. Ills. 800 w. Eng & Min Jour—Oct. 6, 1906. No. 79662.

Clays.

The Clays of Texas. Heinrich Ries. Gives facts concerning these deposits, their geology, classification, physical and chemical tests, and the industry generally. Map and Ills. 10500 w. Bul Am Inst of Min Engrs—Sept., 1906. No. 79853 D.

Graphite.

Occurrence and Uses of Graphite. George Otis Smith. Describes the three general types of occurrence, and indicates the various uses which make it of industrial value. 1600 w. Min Rept—Oct. 18, 1906. No. 80025.

Lead.

An Ontario Lead Deposit. J. Volney Lewis. Describes a galena-calcite vein in siliceous schist in central Hastings County, Ontario, Canada. 1500 w. Ec Geol—July, 1906. No. 79841 D.

Manganese.

Manganese Mining Industry in India. L. Leigh Fermor. Reviews the history of

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this industry, the mining methods, cost of transport and production, and the future prospects. Ills. 3800 w. Ir & Coal Trds Rev—Oct. 19, 1906. No. 80148 A.

Platinum.

The Production of Platinum in 1905. F. W. Horton. From Adv. Sheets, Mineral Resources of the U. S. An explanation of the rise in price of platinum, and its increased production in the United States, where it is found. 1000 w. Min Rept—Oct. 25, 1906. No. 80120.

Salt Mining.

Underground Workings in Potash Salt Mines of Great Depths (Ueber den Abbau von Kalisalzlagerstätten in Grösseren Teufen). H. Kegel. Discussing especially the necessity for effective supports, in view of the difficult nature of the material. 3000 w. Glückauf—Oct. 6, 1906. No. 79937 B.

Tin.

The Malay Tin-Fields. Ralph Stokes. Information concerning the Chinese mine workings and methods. Ills. 1800 w. Min Wld—Oct. 6, 1906. No. 79647.

The Tin-Deposits of the Kinta Valley, Federated Malay States. William R. Rumbold. Describes this district which is probably at the present time the richest alluvial tin-district in the world. Describes the deposits and discusses their origin. Ills. 3800 w. Bul Am Inst of Min Engrs—Sept., 1906. No. 79852.

Zinc.

Composite Metallurgical Vessels. A. L. Queneau. Illustrates and describes a new system of making zinc retorts and refractory crucibles. 2800 w. Eng & Min Jour—Oct. 13, 1906. No. 79775.

Industrial Analysis of Zinc. Messrs. Hollard & Bertiaux. An explanation of methods used. 2000 w. Min Jour—Oct. 6, 1906. No. 79801 A.

Zinc and Lead Mining in Wisconsin. Albert A. Hoskin. Describes the deposits and the features peculiar to this district, and gives the predictions of scientific investigators. 2000 w. Min Rept—Oct. 4, 1906. No. 79649.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Accidents to Passengers on British Railways. Information from a recently issued Blue-Book, reporting the accidents during 1905. 1200 w. Engr, Lond—Sept. 28, 1906. No. 79710 A.

The Railway Accident at Grantham, England. An illustrated account of a serious disaster, Sept. 19, 1906, on the Great Northern Railway. 3500 w. Engng.—Sept. 28, 1906. No. 79706 A.

The Salisbury Accident. Gives Major Pringle's report to the Board of Trade on the accident of July 1, 1906. The minutes of the evidence and the appendices have been omitted. Also editorial. 9000 w. Engr, Lond—Oct. 5, 1906. No. 79807 A.

English Transportation.

What Can America Learn from Great Britain in Transportation? Archibald S. Hurd. Illustrates and describes the growth of the motor-train and motor-bus in England. 2500 w. Cassier's Mag—Oct., 1906. No. 79525 B.

Regulations.

Locomotives in Factories. Gives the draft regulations presented to the Home Secretary of the British Government, for use of locomotives and wagons on lines and sidings in or used in connection with premises under the factory and workshop act. 2500 w. Col Guard—Sept. 28, 1906. No. 79703 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Possible Troubles and Their Remedies. Discusses some of the troubles that may happen to the E. T. equipment and their remedies. 1000 w. Ry & Loc Engng—Oct. 1906. No. 79606 C.

Cars.

All Steel Cars for Passenger Transportation. Illustrates and describes types of passenger cars to be built at the new plant of the Pressed Steel Car Co., Pittsburg, Pa. 1200 w. Ry & Engng Rev—Oct. 27, 1906. No. 80116.

High-Capacity Freight Wagons for the Indian Railways. Illustrates and describes a 20-ton wagon for the Madras Railway; and a covered wagon for the Barsi Light Railway. 1000 w. Col Guard—Sept. 28, 1906. No. 79701 A.

Permanent Stakes for Gondola and Flat Cars. Statistics concerning the expense and waste in the present method of requiring lumber shippers to furnish the stakes necessary, and illustrated description of the Harvey permanent-steel stake as applied to various types of cars. 1300 w. Ry Age—Oct. 19, 1906. No. 80022.

Steel Underframe Postal Car. Illustrated detailed description of a car for the Santa Fé system. 700 w. Am Engr & R R Jour—Oct., 1906. No. 79603 C.

The Herr Dump Car. Construction drawings and description of a car of this type especially adapted to carrying ore. 800 w. Ry Age—Oct. 12, 1906. No. 79762.

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Electrification.

Locomotives vs. Motor Cars. Clement F. Street. From a paper read before the New England R. R. Club. Discusses when electric locomotives are better than motor cars, the advantages of each for certain service, etc. 2200 w. Elec Jour—Oct., 1906. No. 79896.

Steam Locomotive and Electric Operation for Trunk-Line Traffic—A Comparison of Costs and Earnings. Joseph Mayer. Gives arguments tending to show that the electric operation of many steam railroads will be very profitable. Also an appendix on the mechanical theory of the contact conductor for high-speed trains. 15000 w. Pro Am Soc of Civ Engrs—Sept., 1906. No. 79533 E.

Sub-Stations and Transmission System of the New York Central & Hudson River Railroad. Illustrated detailed description. 2200 w. Elec Wld—Oct. 27, 1906. No. 80114.

The New York Central's Terminal Electrification at New York. A full illustrated description of present progress in the work of electrification on this road. 2800 w. R R Gaz—Oct. 5, 1906. No. 79641.

What Are the Possibilities in Operating the Mountain Divisions of Western Railways with Electric Power? A letter from E. N. Percy, describing opportunities for using electricity generated by water-power, with editorial discussion. 3000 w. Eng News—Oct. 4, 1906. No. 79624.

Locomotive Boilers.

The Care of Locomotive Boilers at Terminals and While in Service. Gives the reply of J. F. Roddy (condensed) to a list of questions sent out. Also summary of other replies. 2000 w. Eng News—Oct. 4, 1906. No. 79622.

Locomotive Frames.

The Frame of a Locomotive Considered as a Rigid Beam on Spring Supports (Der Lokomotivrahmen als Starrer Balken auf Federnden Stützen). O. Denecke. A mathematical investigation of the distribution of stresses in the main frames of locomotive engines, with graphical diagrams for practical use. 3500 w. Glasers Annalen—Oct. 15, 1906. No. 79970 D.

Locomotives.

American Tank Locomotives for Japan. Illustration, with description, of engines recently built at Schenectady. 400 w. Ry & Engng Rev—Oct. 27, 1906. No. 80117.

Compound Locomotive for the Northern Railway of France. H. W. Hanbury. Plate and description of this engine and its performance. 2000 w. Engng—Oct. 12, 1906. No. 80057 A.

Details of Four-Cylinder Compound Six-Coupled Locomotive. Illustrated detailed description of a locomotive for the Italian State Railways, shown at the Milan exposition. 1000 w. Engng—Sept. 28, 1906. Serial. 1st part. No. 79705 A.

Freight and Passenger Locomotives with Combustion Chambers. Illustrations of types representing 70 locomotives recently delivered to the Northern Pacific Railway Company, with descriptive notes. 1700 w. Am Eng & R R Jour—Oct., 1906. No. 79602 C.

Latest Express Engines—South-Eastern and Chatham Railway. Charles Rous-Marten. An account of the performance of these engines in regular daily service. 2500 w. Engr, Lond—Oct. 5, 1906. No. 79806 A.

Mallet Articulated Compound Locomotive, Type 2-6-6-2. Illustrated detailed description of locomotives for the Great Northern Railway, which are the heaviest locomotives yet built. 2500 w. Am Engr & R R Jour—Oct., 1906. No. 79600 C.

New Delaware & Hudson Consolidation Locomotives. Illustrated detailed description of heavy locomotives designed for slow freight and pushing service. 800 w. Ry & Engng Rev—Oct. 6, 1906. No. 79646.

New 4-Cylinder Compound Locomotives: Danish State Railways. Charles S. Lake. Drawings and description of large engines of the Atlantic type, with leading dimensions. 800 w. Mech Engr—Oct. 6, 1900. No. 79790 A.

Standardizing Locomotives on the American Railways. A description dealing with the methods and plans adopted in standardizing the locomotive equipment of the system formed by the Southern Pacific Railway and the Union Pacific Railway, and subsidiary lines. 3000 w. Engr, Lond—Oct. 5, 1906. No. 79805 A.

The Compound Locomotive in the Twentieth Century. J. F. Gairns. Considers the work for which these locomotives are suited, the various systems and their general characteristics. 2000 w. Cassier's Mag—Oct., 1906. No. 79530 B.

The Development of American Freight Locomotives. George L. Fowler. An illustrated article giving an outline of improvements made to increase the capacity during the last 25 years. 3000 w. R R Gaz—Oct. 19, 1906. No. 79868.

The Economical Working of Locomotives. William Ernest Dalby. Investigates the economical working and design of locomotives of the simple type. 4000 w. Inst of Civ Engrs—No. 3577. No. 79521 N.

Vauclain Balanced Compound Locomotive for the Chicago and Eastern Illinois Railroad. Illustrates and describes this engine, reporting a test made in comparison with a single-expansion locomotive. 1500 w. Engng—Sept. 21, 1906. No. 79586 A.

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Motor Cars.

Bavarian Rail Motor-Coach. Illustrates and describes this steam coach and its equipment. 700 w. Engr, Lond—Oct. 12, 1906. No. 80062 A.

Rail-Motor-Car Traffic in England. T. H. Riches and S. B. Haslam. From a paper presented at meeting of the Inst. of Mech. Engrs. Information concerning this means of dealing with local and branch line passenger traffic, and related matters. Ills. 4000 w. R R Gaz—Oct. 12, 1906. No. 79748.

The Kobusch-Wagenhals Steam Motor Car. Illustrated detailed description of an unusually large and heavy steam motor car. 600 w. Ry Age—Sept. 28, 1906. No. 79565.

Speed Curves.

Note on Determining the Power of Locomotives by Means of the Speed Curves. Dr. Karl Schlöss. Abstract translation. Explanatory. 2800 w. Bul Int Ry Cong—Sept., 1906. No. 79891 E.

Traction.

The Influence of the Tractive Effort upon the Distribution of Weight in Locomotives (Influence de l'Effort de Traction sur la Répartition de la Charge des Locomotives). F. Maison. Showing that the distribution of weight upon the driving wheels is variable, and considering the case of double traction and the effect of braking. 5500 w. Rev Gén d Chem de Fer—Oct., 1906. No. 79925 G.

Train Lighting.

Incandescent Gas Lighting for Passenger Cars (Eclairage au Gaz à Incandescence des Voitures à Voyageurs). E. Biard and G. Mauclère. Data and results of experience with the ordinary and inverted mantles on the Eastern Railway of France. 7000 w. Rev Gén d Chem de Fer—Oct., 1906. No. 79924 G.

Tests of the Leitner-Lucas Train-Lighting Apparatus. Gives results of recent tests made of this system for the electric-lighting of trains. 1500 w. Engng—Oct. 19, 1906. No. 80140 A.

Tyres.

Japanese Railway Tyre Works at Yawata. Plate and description of this factory for the making of tyres for railway and tramway vehicles. 2400 w. Engng—Oct. 19, 1906. No. 80141 A.

Valve Gear.

The Walschaert Valve Gear as Applied to Locomotives. James Kennedy. An illustrated paper explaining the advantages to be derived from the use of this gear, followed by general discussion. 10000 w. Pro N Y R R Club—Sept. 21, 1906. No. 79843.

NEW PROJECTS.

Canada.

Railroad Building in Canada. Reports remarkable activity in railroad construction and development. 1000 w. R R Gaz—Oct. 12, 1906. No. 79749.

New Line.

Construction on the Bay Shore Line of the Southern Pacific Co. Interesting construction methods are illustrated and described, especially tunnel work. 1500 w. Ry & Engng Rev—Oct. 20, 1906. No. 80011.

The Santa Fé's New Line Through the Arkansas Valley. Map and description of this new line through one of the richest irrigated districts of the United States. 1200 w. Ry Age—Sept. 28, 1906. No. 79564.

Transcontinental.

Developments in the Trans-Continental Railway System. A map showing ten important additions to the trans-continental railway system, giving particulars of these new lines. 2500 w. Eng News—Oct. 4, 1906. No. 79620.

PERMANENT WAY AND BUILDINGS.

Construction.

The South & Western Railway. Illustrated description of interesting construction work on this new line which will furnish a direct, low-grade line from the coal fields of Virginia and Kentucky to Southern tide-water ports. It includes 33 tunnels, and the cost of the line will average $125,000 per mile. 1800 w. Ry Age—Oct. 19, 1906. Serial. 1st part. No. 80021.

Ferry Terminal.

The Manhattan Island Ferry Terminal for the West Shore. Plan and description of a new terminal to be built by the New York Central R. R., at West 42d Street, in New York City. 1500 w. Ry Age—Oct. 5, 1906. No. 79645.

India.

The Railway-Gauges of India. Sir Frederick Robert Upcott. A review of present conditions, as introductory to a discussion of the best course to take for the future development of traffic. Discussion, drawings and map. 60000 w. Inst of Civ Engrs—No. 3586. No. 79513 N.

Interlocking.

Baltimore & Ohio Interlocking Plant at Watersville Junction. Plan and description of a mechanical interlocking signal plant recently installed in Maryland. 1000 w. Ry Age—Sept. 28, 1906. No. 79566.

Line Stakes.

Setting Line Stakes on Existing Railroad Curves by Middle Ordinates. G. W. Snyder. Gives an explanation of this method. 800 w. R R Gaz—Oct. 19, 1906. No. 79867.

Rail Fastenings.

A Discussion of Screw Bolts for Rail Chairs (Considérations Générales sur la Facilité de Descente des Tirefonds). E.

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Perrond. An experimental investigation into the force required to screw the bolts into wooden cross ties without injuring the wood. The Collet torsiometer is described. 4000 w. 1 plate. Rev Gen d chem de Fer—Aug., 1906. No. 79923 G.

Screw Connections for Metal Cross Ties for Railways (Le Deserrage des Vis dans les Assemblages Métalliques des Voies de Chemins de Fer). L. Schüssel. With illustrations of a variety of metal cross ties used in France, showing methods of securing the rails. 2500 w. Génie Civil—Sept. 22, 1906. No. 79910 D.

Rail Heads.

Removable Rail Heads. William H. Booth. Illustrated description of the system of the Romopac Tramway Construction Co., Ltd., Leeds, England. 800 w. Cassier's Mag—Oct., 1906. No. 79527 B.

Rail Joints.

Wheel Carrying Rail Joints and Tie Preservation. Max Barschall. Gives information concerning these joints and illustrations and description of the new method for applying wheel-carrying joints. Also remarks on the improved process of treating ties. 1500 w. Bul Int Ry Cong—Sept., 1906. No. 79890 E.

Rails.

Historical Sketch of the First Cast and Malleable Iron Railway Rails. George P. Raidabaugh. Historical review with outline drawings. 1500 w. Sib Jour of Engng— Oct., 1906. No. 80002 C.

Shops.

Organization and Economy in the Railway Machine Shop. H. W. Jacobs. The third paper discusses the broad problems of centralizing and balancing the tool equipment for an entire railway with a view of obtaining the maximum efficiency of the plant. 4000 w. Engineering Magazine—Nov., 1906. No. 79993 B.

Signals.

Electro-Pneumatic Block Signals on the Electrified Line of the West Jersey and Seashore. An illustrated description of the signal installation on this line between Camden, N. J., and Atlantic City. 2000 w. R R Gaz—Oct. 5, 1906. No. 79642.

Operation of Railway Points and Signals by Power. Illustrates and describes the low-pressure pneumatic system installed at Basingstoke, on the London and South Western railway. 3300 w. Engng —Sept. 28, 1906. No. 79704 A.

Station.

The El Paso Union Passenger Station. Illustrated detailed description of this Texan station recently opened for traffic. 1200 w. Ry Age—Oct. 5, 1906. No. 79643.

Switches.

Devices to Keep Railroad Switches from Becoming Clogged with Snow and Ice. Francis G. Shaw. Read before the Ry. Sig. Assn. Gives the claims made for these devices, and describes two systems; one a gas-burning device, the other a hot oil circulation. 700 w. Eng News—Oct. 18, 1906. No. 79833.

Terminals.

New Passenger Terminal of the Chicago & North-Western at Chicago. An account of this new station which will provide complete separation of passengers and freight traffic. 600 w. R R Gaz—Oct. 12, 1906. No. 79751.

The New Freight Terminal at St. Louis of the Rock Island-Frisco Lines. Plan, elevation and details are illustrated and described. 800 w. R R Gaz—Oct. 12, 1906. No. 79752.

The Plant of the Pittsburg and Lake Erie Railway at Pittsburg (Die Anlagen der Pittsburg und Lake Erie Eisenbahn in Pittsburg). E. Giese and Dr. Blum. With plans of the station yards and general terminal arrangements at Pittsburg, and at McKees Rocks, as viewed by two German engineers. 3500 w. Zeitschr d Ver Deutscher Ing—Oct. 6, 1906. No. 79906 D.

The Railroad Terminal Problem. Editorial on the necessary reconstruction of important passenger stations, especially the great stations of large cities, the demands of the public, the immense cost, etc. 1500 w. R R Gaz—Oct. 26, 1906. No. 80086.

TRAFFIC.

Clearing Houses.

Car Clearing Houses, Car Pools, etc. J. W. Midgley. Discussing remedies for the misuse of freight cars. 3500 w. Ry Age—Oct. 5, 1906. No. 79644.

Interchange.

Interchange of Traffic Between Electric Lines and Steam Railroads. C. A. Paul. Read before the Nat. Assn. of Ry. Agents. Reviews the electric traction situation in its relation to the steam railroads, and the changes taking place, with remarks on future possibiities. 1000 w. R R Gaz—Oct. 26, 1906. No. 80088.

MISCELLANY.

Japan.

Official Statistics of Japanese Railways. Slason Thompson. An illustrated article giving a summary, taken from the latest annual report, concerning the nationalization of 17 private railways. 500 w. Ry Age—Oct. 12, 1906. No. 79763.

Surcharges.

The Surcharge Problem. C. J. Morrison. Discusses the surcharges on a modern railway shop, and when it is an advantage to purchase instead of manufacture. 1200 w. Am Engr & R R Jour—Oct., 1906. No. 79601 C.

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STREET AND ELECTRIC RAILWAYS

Ballast.

Ballast. C. H. Clark. Read at the Columbus convention of the Am. St. & Int. Ry. Engng. Assn. An illustrated description of the practice and methods adopted at Cleveland, Ohio. Also reports concerning steel ties. 1500 w. St Ry Jour—Oct. 20, 1906. No. 80027 C.

Brakes.

Braking for Electric Cars. George C. Graham. Read before the N. Y. State St. Ry. Assn. Considers the systems in use, favoring the "Straight air" brake. Ills. 1500 w. St Ry Jour—Sept. 29, 1906. No. 79560 C.

Brakes for Tramway Cars. Henry M. Sayers. Discusses the requirements and the need of having two brakes on a car, special brakes for descending hills, etc. 1400 w. Elect'n, Lond—Sept. 28, 1906. Serial. 1st part. No. 79696 A.

Car Brakes. Henry Mozley. Read at conference of the Munic. Tram Assn. Gives the writer's experience at Burnley, explaining why the mechanical brakes with cast iron slippers were adopted, and describing the construction and operation. Ills. 3000 w. Elec Engr, Lond—Sept. 21, 1906. No. 79574 A.

Different Systems of Brakes. H. S. Williams. Read before the N. Y. State St. Ry. Assn. Principally a description of the systems of air brakes adaptable to electric cars with multiple-unit control. 2000 w. St Ry Jour—Sept. 29, 1906. No. 79561 C.

Cables.

Underground Cables. H. G. Stott. Read at Columbus convention of the Am. St. & Int. Ry. Engng. Assn. Considers the insulation of high-tension cables, and discusses troubles and their remedies. 2300 w. St Ry Jour—Oct. 20, 1906. No. 80029 C.

Car Equipments.

Car Equipment and Maintenance. S. D. Shenstone. Read before the Elec. Assn. of N. S. W. Information concerning direct-current tram car equipments, 5000 w. Aust Min Stand—Aug. 22 and 29, 1906. Serial. 2 parts. No. 79594, each B.

Cars.

New Double-Deck Car of the Twin City Rapid Transit Company. Illustrates and describes a type of car for service on the interurban line to Lake Minnetonka. 1200 w. St Ry Jour—Oct. 6, 1906. No. 79638 C.

Car Service.

Economy in Car Equipment, Weights and Schedules. E. H. Anderson. Read before the Am. St. & Int. Ry. Engng. Assn. Discusses the dynamic features of car service and the effect on the cost. 1400 w. St Ry Jour—Oct. 20, 1906. No. 80031 C.

Chicago Subway.

The Proposed "Inner Circle" System of Chicago Subway Terminals. Arthur S. Robinson. An explanation of this scheme for the terminals of the Chicago subway. Ills. Discussion. Also followed by a letter from B. J. Arnold, with illustrations and descriptions of the systems he proposed. 16000 w. Jour W Soc of Engrs—Oct., 1906. No. 80007 D.

Columbus, Ohio.

The Electric Railway Systems of Columbus. Reviews features of the Columbus Railway & Light Company. Ills. 4000 w. St Ry Jour—Oct. 13, 1906. (Convention Sec.). No. 79814 C.

Depreciation.

Depreciation and Renewals Funds in Relation to Tramways Undertakings. G. W. Holford. Read before the Munic. Tram. Assn. Gives a tabulated statement showing the provision made by tramway undertakings with regard to a depreciation and renewals fund, considering rolling-stock, buildings, overhead equipment, and permanent way. 2500 w. Elec Engr, Lond—Sept. 28, 1906. No. 79686 A.

Developments.

Electric Railway Developments. A general review of the recent great developments, with remarks on the future outlook. 2200 w. Sci Am Sup—Oct. 13, 1906. No. 79757.

Elevated Railways.

Elevated Railways and their Bearing on Heavy Electric Traction. H. M. Brinckerhoff. Read before the Am. St. & Int. Ry. Engng. Assn. Presents features in elevated electric railway operation that may have a bearing on the "heavy traction problem." 3500 w. St Ry Jour—Oct. 20, 1906. No. 80032 C.

Equipments.

Electrical Equipments of the Columbus City and Interurban Railway Systems. An illustrated article describing in detail the equipments of the railway systems of this Ohio city. 3500 w. Elec Wld—Oct. 13, 1906. No. 79770.

Europe.

Tramway Lines on the Continent. C. L. Durand. Brief illustrated descriptions of the Mediterranean Coast-line, Rouen line, and the Rome tramways. 4000 w. Elec Rev, N Y—Oct. 13, 1906. No. 79769.

Evolution.

Some Notes on the Evolution of Electric Transportation. Theodore Stebbins. A record of distinctions in construction and operation of electric traction in its

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various applications. 3000 w. St Ry Jour —Oct. 20, 1906. No. 80035 C.

Feeding.

Advantages and Disadvantages of Feeding Tramway Systems in Isolated Zones as Compared with Closed Networks. Abbreviated translation of a report by M. Piazzoli, on the replies received to questions sent out, presenting the advantages of the system of feeding by isolated zones. 3000 w. Elect'n, Lond—Oct. 19, 1906. No. 80133 A.

Freight.

Freight and Express. Reviews the latest methods for handling freight and express on interurban roads. Ills. 7000 w. St Ry Jour—Oct. 13, 1906. (Convention Sec.). No. 79821 C.

Interurban Freight and Express. Edward C. Spring. Read before the Am. St. & Int. Ry. Engng. Assn. Critical discussion of this branch of the interurban service. 2200 w. St Ry Jour—Oct. 20, 1906. No. 80033 C.

Methods of Handling Freight on the Dayton & Troy Electric Railway. An Explanation of the methods of a company which operates a 31-mile interurban electric line in Ohio. 2500 w. Elec Ry Rev —Oct., 1906. No. 79654.

Incline Railways.

The New Inclines of the Sao Paulo Railway, Brazil. James Fforde. Illustrated descriptions of improvements to meet increase of traffic. Easier gradients, the adoption of the "endless rope," etc. 2400 w. Inst of Civ Engrs—No. 3614. No. 79517 N.

Interurban.

A 1000-Volt Direct-Current Interurban Railway. Illustrates and describes interesting features of the railway in operation between Cologne and Bonn, along the bank of the Rhine. 1000 w. Elec Engr, Lond—Oct. 19, 1906. No. 80129 A.

The Groton & Stonington Street Railway. An illustrated description of a line from Groton, Conn., to Westerly, R. I., its construction, operation, etc. 3000 w. St Ry Jour—Oct. 6, 1906. No. 79637 C.

The Toledo and Chicago Interurban Railway. Illustrated detailed description of this new single-phase line for passenger and freight traffic. 1800 w. Elec Ry Rev—Oct., 1906. No. 79652.

Wemyss and District Tramways. An illustrated description of this short interurban line in Scotland, which includes sections of tramway and light railway, with an explanation of how the scheme was carried out. 2400 w. Tram & Ry Wld—Oct. 4, 1906. No. 79863 B.

Lines.

Lines and Cables. Discusses high-tension transmission lines and overhead construction for interurban roads. 4200 w. St Ry Jour—Oct. 13, 1906. (Convention Sec.) No. 79819 C.

Motors.

Distribution of Motors on Trucks. Cale Gough. Gives an outline of the methods by which the problem can be solved for any given case. 4000 w. St Ry Jour—Oct. 16, 1906. No. 79639 C.

N. Y. Central R. R.

Port Morris Power Station of the New York Central & Hudson River Railroad. Illustrated detailed description of this station and its equipment. It is now ready to operate the initial electric zone of the N. Y. C. & H. R. R. R. Co. 3000 w. Elec Wld—Sept. 29, 1906. No. 79544.

N. Y. Subway.

Cooling the New York Subway. Diagrams and descriptions of the new ventilating system and the experimental cooling plant. Ills. 2000 w. Elec Rev, N Y —Oct. 20, 1906. No. 79880.

Operation.

Electric Railways in Sparsely Settled Communities. E. P. Roberts. Read before the Am. St. & Int. Ry. Engng. Assn. Considers local conditions and peculiarities that affect earnings, giving statistics and discussing their value, and many matters having a bearing on this subject. 12000 w. St Ry Jour—Oct. 20, 1906. No. 80034 C.

Municipal Operation of Tramways: Some Points of a Committee's Policy. R. A. Smithson. Discusses questions coming before tramway committees for decision. Also brief general discussion. 3500 w. Elect'n, Lond—Sept. 28, 1906. No. 79699 A.

Schedules, Limited Services, Speeds, Fares, Despatching and Miscellaneous Matters. Outlines the latest practice. Ills. 11000 w. St Ry Jour—Oct. 13, 1906. (Convention Sec.) No. 79820 C.

Rolling Stock.

Latest Practice in Rolling Stock Design and Equipment. Reviews interurban practice in car design, seats, trucks, wheels, lubrication, brakes, brake shoes, motors, and controllers, trolley wheels, signal lights, fenders and pilots, sanders, signs, and other rolling stock matters. Ills. 1400 w. St Ry Jour—Oct. 13, 1906. (Convention Sec.) No. 79817 C.

Scioto Valley.

Some Practices on the Scioto Valley Traction System. Reviews some of the operating methods of this interurban road. Ills. 10500 w. St Ry Jour—Oct. 13, 1906. (Convention Sec.) No. 79815 C.

Simplon.

Electrical Equipment of the Simplon Tunnel. Dr. Alfred Gradenwitz. An illustrated article describing how plants formerly supplying power for use in building the tunnel have been adopted for feeding the three-phase trolley system. 1500 w. Elec Ry Rev—Oct., 1906. No. 79655.

We supply copies of these articles. See page 479.

Electric Traction in the Simplon Tunnel. Illustrations and interesting particulars of the electrical installation which is now in operation. 3000 w. Elect'n, Lond—Sept. 28, 1906. No. 79697 A.

Single Phase.

Report of the International Exposition at Milan (Bericht von der Internationalen Ausstellung zu Mailland). Describing some of the electrical features, with particular reference to the Finzi single-phase railway. 2000 w. Elektrotech Zeitschr—Oct. 11, 1906. No. 79961 B.

Single Phase Equipment for the Washington, Baltimore & Annapolis Railway. Information in regard to the equipment of this line, which is one of the largest and most important installations of the single-phase system yet undertaken. 1200 w. R R Gaz—Oct. 12, 1906. No. 79750.

Tests and Operation of the Single-Phase Locomotive on the Seebach-Wettingen Railway (Messresultate und Betriebserfahrungen an der Einphasen-Wechselstrom lokomotive mit Kollektormotoren auf der Normalbahnstrecke Seebach-Wettingen). W. Kummer. With curves showing the performance, and a profile of the line. 2500 w. Schweiz Bauzeitung—Sept. 29, 1906. No. 79974 B.

The Toledo & Chicago Interurban Single-Phase Railway. John R. Hewett. An illustrated account of the overhead line equipment, controllers and motors of this recently completed railway. 4000 w. St Ry Jour—Oct. 13, 1906. No. 79813 C.

See also Electrical Engineering, Motors.

Starting.

Grid Starting Coils. Henry Schlegel. A statement of facts about grid coils, explaining their advantages. 3000 w. St Ry Jour—Oct. 6, 1906. No. 79640 C.

Station.

Spy Run Generating Station of the Fort Wayne & Wabash Valley Traction Company, Fort Wayne, Ind. Illustrated detailed description of this high-tension generating station and its equipment. 1500 w. Elec Ry Rev—Oct., 1906. No. 79653.

The Central Power Station of the Chicago & Western Indiana Ry. Illustrated description of this station and its equipment, designed to meet unusual requirements for lighting, heating, power, etc. 2500 w. Eng Rec—Oct. 6, 1906. No. 79668.

Stray Currents.

See Civil Engineering, Materials.

See also Electrical Engineering, Distribution.

Surface Contact.

Krizik Surface Contact System at Prague. Illustrated description of the system, with brief explanation of why it was adopted. 1000 w. Elect'n, Lond—Oct. 5, 1906. No. 79797 A.

Terminal.

The New Terminal Building of the Indiana Union Traction Company at Muncie, Indiana. Views and working plans of the latest passenger and freight terminal building erected by this company. 1200 w. St Ry Jour—Oct. 13, 1906. No. 79812 C.

Ties.

Ties, Poles and Posts. C. A. Alderman. Read at Columbus convention of the Am. St. & Int. Ry. Engng. Assn. Discusses materials used and proposed, giving specifications for ties in use by the Cincinnati Northern Traction Co., and deductions made by W. C. Cushing. Ills. 2700 w. St Ry Jour—Oct. 20, 1906. No. 80028 C.

Tracks.

The Reconstruction of the Olive Street Track. Richard McCulloch. An illustrated account of track work in St. Louis. 4500 w. Jour Assn of Engng Socs—Aug., 1906. No. 79893 C.

Tramway Track Work. R. C. Bullough. Read before the Munic. Tram. Assn. Discusses important matters concerning present-day tramway track work. 2500 w. Elec Engr, Lond—Sept. 28, 1906. No. 79687 A.

Trolley Wagon.

Fifty-Ton Trolley Wagon. Illustrated description of a car built for their own use by the North-Eastern Railway of England. 600 w. Ry & Loc Engng—Oct., 1906. No. 79605 C.

Ventilation.

Shifting Winds and Cooler. An illustrated article describing the improved ventilation of the N. Y. Rapid Transit Subway. 1700 w. Ry & Loc Engng—Oct., 1906. No. 79604 C.

Ventilation of the Boston Subway. Howard A. Carson. An illustrated explanation of the general scheme of ventilation, with estimate of the cost. 2700 w. Pro Am Soc of Mech Engrs—Oct., 1906. No. 79856.

Way.

Way and Way Matters. Reviews the practice of interurban roads with regard to rails, joints, bonds, ties, ballast, turnouts, crossings, bridges, signals, terminal stations, way stations and miscellaneous way matters. Ills. 9000 w. St Ry Jour—Oct. 13, 1906. (Convention Sec.) No. 79816 C.

Wheeling, W. Va.

The Wheeling Traction System. An illustrated account of recent extensive work in the elimination of grades and curves by the construction of a cut-off, with particulars of the cost. 5000 w. St Ry Jour—Oct. 13, 1906. No. 79811 C.

Wheels.

The Removal of Car Wheels. James Andrews. Considers the causes that make removals necessary, etc. 1800 w. St Ry Jour—Sept. 29, 1906. No. 79562 C.

We supply copies of these articles. See page 479.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *m.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Electrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy, United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Review. *w.* Cleveland, U. S. A.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Fôrderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pac. Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Klijk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.